A Revision of the Recent *Calliostoma* Species of New Zealand (Mollusca: Gastropoda: Trochoidea)

Bruce A. Marshall
Museum of New Zealand Te Papa
Tongarewa
P.O Box 467
Wellington, New Zealand

ABSTRACT

Thirty-three Recent calliostomatids are recorded from New Zealand, ten of which are described as new. *Calliostoma (Otukaia) blacki* (Dell, 1956) is renamed due to homonymy, and the following taxa are newly synonymized: *Venustas tigris chathamensis* Dell, 1950 with *Calliostoma (Maurea) tigris* (Gmelin, 1791); *Maurea punctulata ampla* Powell, 1939 and *V. punctulata multigemmata* Powell, 1952 with *C. granti* (Powell, 1931); *V. couperi* Vella, 1954 and *Thoristella chathamensis profunda* Dell, 1956 with *C. blacki* (Powell, 1950), which is resurrected from synonymy under *C. foveauxanum* (Dell, 1950); *Zizyphinus hodgei* Hutton, 1875, *Z. pondcrosus* Hutton, 1885, and *C. carnicolor* Preston, 1907 with *C. selectum* (Dillwyn, 1817); *C. undulatum* Finlay, 1923 and *C. pellucidum spiratum* Oliver, 1926 with *C. pellucidum* (Valenciennes, 1846). Lectotypes are designated for *Trochus selectus* Dillwyn, 1817, *T. pellucidus* Valenciennes, 1846, and *Calliostoma onustum* Odhner, 1924

Key words: Mollusca; prosobranch gastropods; Trochoidea; Calliostomatidae; *Calliostoma*; systematics

INTRODUCTION

The family Calliostomatidae comprises about 250 living species. They occur in all oceans from the intertidal zone to about 3000 meters depth, mostly on rocky ground. All known species are carnivores, most feeding on cnidaria, and sometimes carion, though a few feed exclusively on sponges. The group is particularly well represented in the New Zealand region, with 33 living endemic species, including some of the worlds largest, notably *Calliostoma (Maurea) tigris* (Gmelin, 1791), which may exceed 100mm in shell height.

Besides the 33 Recent species recorded herein, at least double this number are known from the New Zealand Cenozoic (Early Eocene—Early Pleistocene), of which more than half are undescribed. Several of the living species have excellent fossil records in the extensive Plio-Pleistocene deposits of the southern North Island, and fossil material is recorded and discussed where appropriate.

Two of the recorded Recent species, both of which are type species of new genera, together with a new genus for *Calliostoma onustum* Odhner, 1924 are named elsewhere (Marshall, 1995). Five additional species are known from off the Kermadec Islands (Appendix).

Attention is drawn to the fact that calliostomatid shell morphology tends to become more variable with increasing size/age, so that species with dissimilar early teleoconchs can be superficially similar at maturity and vice versa. For accurate discrimination of species (and for objective descriptions), it is thus essential to trace and compare the development of individual sculptural elements from the earliest teleoconch whorls following the system used by Ikebe (1942) and Marshall (1988, 1995) (Figure 28).

ABBREVIATIONS AND TEXT CONVENTIONS

AUG	Geology Department, Auckland University
BMNH	The Natural History Museum, London
MNHN	Muséum National d'Histoire Naturelle, Paris
MNZ	Museum of New Zealand, Wellington
NZGS	Institute of Geological and Nuclear Sciences, Lower Hutt
NZOI	National Institute of Water and Atmospheric Research, Wellington
sa	spire angle (see below)
ZMA	Zoological Museum, Amsterdam

Spire angle measurements for individual shells were averaged (mean spire angle) to reduce bias induced by cyrtoconoid spire profile and expanded or narrowed last adult whorl. In other words, for a shell with a cyrtoconoid spire outline, which becomes more narrowly conical with increasing shell size, the given spire angle is the mean of the maximum and minimum spire angles measured from that specimen. Vice versa for a shell with an evenly conical or coeloconoid contour in which the last adult whorl expands more rapidly than the previous ones. In illustrations of shells, height dimension precedes diameter.

Readers requiring more detailed information on New Zealand stratigraphy should refer to Fleming (1953), Beu and Maxwell (1990), and Abbott and Carter (1994).

SYSTEMATICS

Order **Vetigastropoda** Salvini-Plawen, 1980
Superfamily **Trochoidea** Rafinesque, 1815
Family **Calliostomatidae** Thiele, 1924
Genus *Calliostoma* Swainson, 1840

Calliostoma Swainson, 1840:218, 351. Type species (by subsequent designation of Herrmannsen, 1846:154): *Trochus conulus* Linnaeus, 1758; Recent, north-eastern Atlantic and Mediterranean. For further discussion and synonymy, see Marshall (1995).

Subgenus *Maurea* Oliver, 1926

Maurea Oliver, 1926:108. Type species (by original designation): *Trochus tigris* Gmelin, 1791; Recent, New Zealand [20th December 1926-see below].

Mauriella Oliver, 1926:109. Type species (by original designation): *Trochus punctulatus* Martyn, 1784; Recent, New Zealand [20th December 1926].

Calliotropis Oliver, 1926:110. Type species (by original designation): *Trochus cunninghami* Gray, 1834 = *Trochus selectus* Dillwyn, 1817; Recent, New Zealand. Not *Calliotropis* Seguenza, 1903 [20th December 1926].

Mucrinops Finlay, 1926:360. Type species (by original designation): *Ziziphinus spectabilis* A. Adams, 1855); Recent, New Zealand [23 December 1926].

Venustas Finlay, 1927:360. Type species (by original designation): *Trochus tigris* Gmelin, 1791; Recent, New Zealand [10 March 1927]. Officially rejected name (ICZN Opinion 479). Not *Venustas* Allan, 1926.

Calotropis Thiele, 1929:49. Replacement name for *Calliotropis* Oliver not Seguenza.

Remarks: As indicated by Beu *et al.* (1969), *Venustas* Allan, 1926 (Allan, 1926) was published on 7th December 1926 (ICZN opinion 479) and has priority over *Maurea* Oliver, 1926 (and the officially rejected name *Venustas* Finlay, 1927). Fortunately the type species of *Venustas* Allan (*Calliostoma fragile* Finlay, 1923; Early Miocene, New Zealand) seems unlikely to be consubgeneric with *Calliostoma (Maurea) tigris* (Gmelin, 1791), the type species of *Maurea*. The paper in which Oliver (1926) introduced *Maurea* was published in Parts II / III of Volume 17 of the Proceedings of the Malacological Society of London, the date of publication of which was interpreted as 20th December 1926 by Dell (ICZN Opinion 479) on the basis of a letter from L. R. Cox to M. K. Mestayer bound into the MNZ volume of the journal. This letter is dated 19th April 1927. The title page to Volume 17, issued on 30th December 1927, states that Parts II and III were issued on 30th December 1926. Whereas I have been unable to trace any firmer evidence that Parts II and III were published prior to 30th December, for the sake of nomenclatural stability it is appropriate to follow ICZN acceptance (right or wrong) of 20th December 1926, otherwise *Maurea* would fall as a junior synonym of *Mucrinops* Finlay, 1926 (23 December). *Maurea* is not endangered by *Venustas* Finlay, which has been deemed to have been published on 10th March 1927 and officially rejected (ICZN Opinion 479).

The type species of *Maurea*, *Calotropis*, *Mauriella*, and *Mucrinops* are similar to the type species of *Calliostoma* in radular morphology and external anatomy. Although I am unable to justify genus-level status for *Maurea*, it would be inappropriate to treat it as a synonym of *Calliostoma* because all of the New Zealand species are strongly dissimilar to the type species of *Calliostoma* in shell morphology. On the other hand, there is strong mosaic overlap between the type species of *Maurea*, *Calotropis*, *Mauriella*, and *Mucrinops* via the other Recent species herein referred to *Maurea*, and I am unable to justify segregation of these genus-group taxa from each other. Accordingly, they are all interpreted as synonyms of *Maurea*, which in turn is interpreted as a subgenus of *Calliostoma*. Although the origins and relationships of the Recent species are obscure, it is nevertheless clear that *Maurea* as here limited is polyphyletic. In whatever way the Recent species are arranged in groups, most or all contain species of exceptionally large size for the family. With the exception of "*Trochus*" *mutus* Finlay, 1924 and "*Benthastelena*" *susanae* Maxwell, 1992 (Late Eocene—Early Miocene), which are not closely related to any taxa living in the New Zealand region, none of the numerous pre-Pliocene species from New Zealand exceeds much more than about 20 mm in maximum shell dimension, so it would seem that gigantism occurred independently in several species groups after the Miocene. Many of the pre-Pliocene species are similar to the type species of *Fautor* Iredale, 1924 (*Ziziphinus comptus* A. Adams, 1854; Recent, southern Australia) and other species referred there (as a subgenus of *Calliostoma*) by Marshall (1995) from the New Caledonia area. *Calliostoma regale* new species and *C. aupourianum* new species from northern New Zealand are similar to these small-shelled New Caledonian *Fautor* species and to many of the New Zealand pre-Pliocene taxa, and because (independently derived) gigantism alone is no criterion for genus-group discrimination, it is thus difficult to justify segregation of *Maurea* even from the prior *Fautor*. Evidently highly conservative external anatomy and gross shell and radular morphology are inadequate to construct objectively definable supraspecific groupings, or rather, real phylogenetic groups are rendered nebulous and are obfuscated due to conservation, convergence, gigantism, and uncertain character-state polarity. Molecular cladistic techniques would seem to be a promising source of data for resolution of these problems. For more detailed discussion see Marshall (1995).

Calliostoma (Maurea) tigris (Gmelin, 1791)
(Figures 1-9, 110, 127)

Chemnitz, 1781:100, pl. 170, figs. 1654, 1655.

Trochus tigris Martyn, 1784, fig. 75. (Officially rejected name—ICZN Opinion 479).

Trochus granatum Gmelin, 1791:3584 (refers to Chemnitz, 1781, pl. 170, figs. 1654, 1655); Lamarck, 1822:26; Fischer, 1875-69, pl. 15, fig. 1.

Trochus tigris Gmelin, 1791:3585 (refers to Martyn, 1784, fig.

75) (Officially accepted name—ICZN Opinion 479); Philippi, 1848:50, pl. 10, figs. 16, 17.
Turbo granatum—Röding, 1798:88.
Ziziphinus tigris—Gray, 1843:237.
Zizyphinus tigris—Reeve, 1863, fig. 4, Hutton, 1873:38.
Zizyphinus granatum—Hutton, 1880:98; Hutton, 1884:359.
Calliostoma granatum—Pilsbry, 1888:313, pl. 41, fig. 30.
Calliostoma tigris—Pilsbry, 1889:333; Suter, 1897:280, Suter, 1913:148, pl. 40, fig. 6.
Calliostoma (Maurea) tigris—Oliver, 1926:108; Wenz, 1938: 282, fig. 600; Shikama, 1964:106, fig. 185
Venustas (Venustas) tigris—Finlay, 1926:360, 371
Maurea tigris—Powell, 1937:64, pl. 1, fig. 12; Matsukuma, Okutani & Habe, 1991, pl. 17, fig 11.
Venustas tigris tigris—Dell, 1950:41, figs. 22, 23, 24
Venustas tigris chathamensis—Dell, 1950:43, figs. 26, 27. **New synonym**.
Maurea tigris tigris—Powell, 1957:88, pl.1, fig. 12; Powell, 1979:60, pl. 10, fig. 1.
Maurea tigris chathamensis—Powell, 1957:88; Powell, 1979. 61, pl. 19, fig. 3.
NOT *Zizyphinus granatum*—Reeve, 1863.pl.1, fig. 2 (*C. pellucidum*).

Type Data: *Trochus tigris*: Martyn, 1784, fig. 75, "New Zealand"; *Trochus granatum*: Chemnitz, 1781, pl. 170, figs. 1654, 1655, "Neuseeland"; *Venustas tigris chathamensis* : Holotype MNZ M.2128, Mangare Island, Chatham Islands.

Other Material Examined: *Fossil*—Boulder at head of largest bend in Wainui Stock Road, Ohope (map ref. W15/638502), B.A. Marshall, 1965 (late Castlecliffian, Late Pleistocene) (1 MNZ); Banks of Ohinekoao Stream, coastal cliffs, Matata, B.A. Marshall, 1969 (late Castlecliffian, Late Pleistocene) (1 MNZ). *Recent*—478 specimens in 198 lots MNZ, 13 specimens in 8 lots NZOI.

Distribution (figure 9): Mid-Pleistocene (late Castlecliffian) to Recent, off Three Kings, North, South, Stewart and Chatham Islands, living at 0-211 m on rocky substrata.

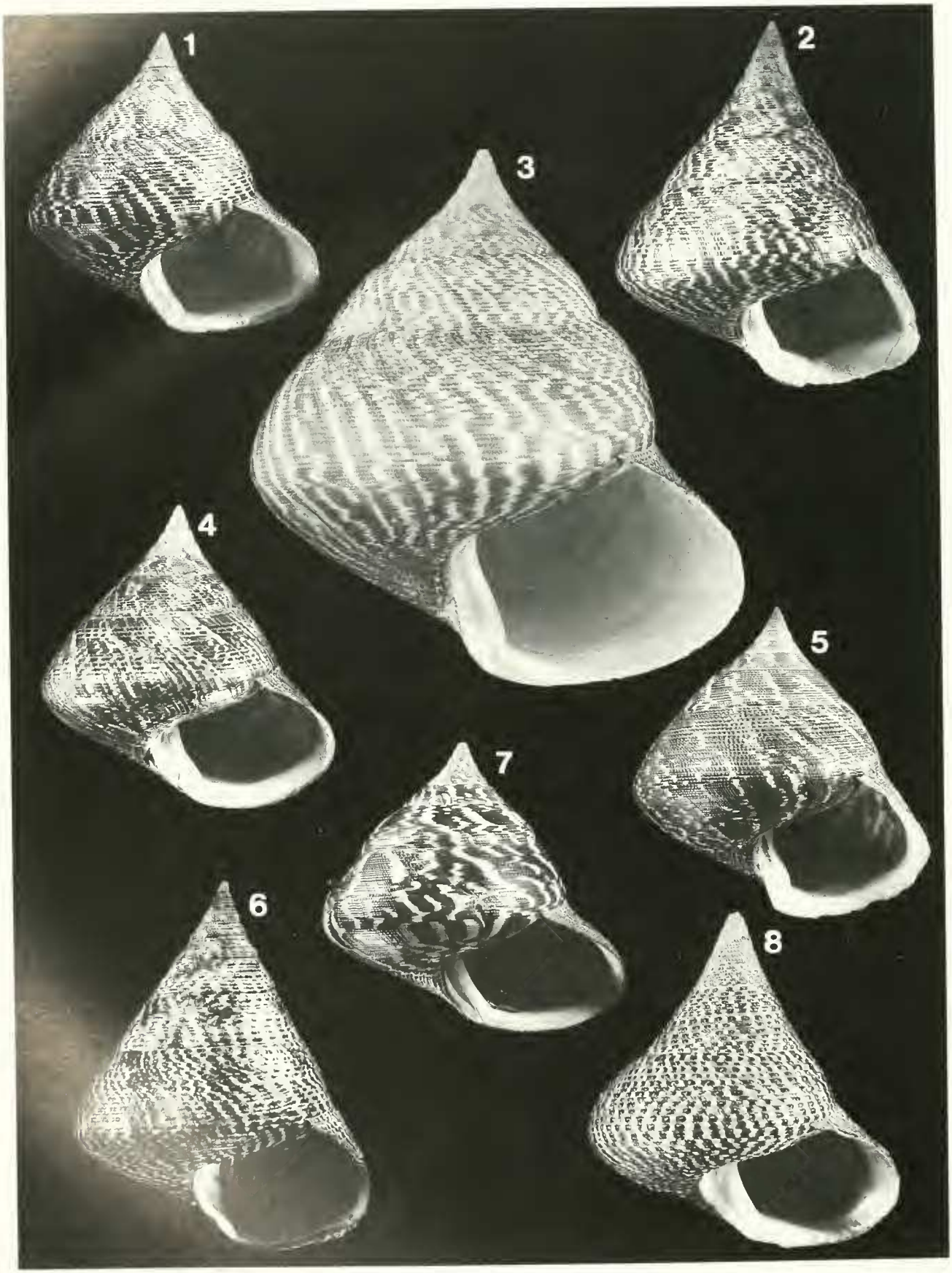
Diet: All guts examined contained theeate hydroids (Cnidaria) and indeterminate tissue.

Remarks: This well-known species, the largest known calliostomatid, is characterised by its large size, relatively thin shell, coeloconoid spire, very narrowly conical and distinctively sculptured early teleoconch (figure 108), and by the (usual) colour pattern of yellowish or reddish brown wavy axial bands. Sculptural development in normal specimens (see below) proceeds through a distinctive intermediate stage in which the spiral cords become weakly nodular or smooth and much broader than the interspaces, then reverts to strongly nodular with wider interspaces on the last adult whorl. Mature specimens have a gently sloping shoulder on the last part of the last whorl, a pronounced thickening within the outer lip, and typically a slight abapical descent of the apertural rim. Shells having adult characteristics may be as small as 27.5 mm in height (MNZ M.84227, Cape Runaway), although most are about twice this size. The species attains exceptional size off the Three Kings Islands (height up to 100 mm, figure 3).

Most specimens from Parengarenga Harbour (figure 6) and many specimens from off eastern Northland (figure 2), including Whangamata and the Aldermen Islands in the northern Bay of Plenty, have appreciably narrower spire angles than specimens from north of Cape Reinga, from Hauraki Gulf, and from south of Mayor Island, Bay of Plenty (sa = 61-72°, mean 66°, S.D. 3.26, n = 20 as against sa = 68-87°, mean 77°, S.D. 3.91, n = 58). There is complete intergradation between narrowly and broadly conical forms, however, both within and between populations, and there are no other differences between them. Because narrowly conical forms occur only in the warm waters off the north-eastern North Island, it would seem that differences in spire angle are linked in some way to sea temperature (see *C. blacki* below). The occurrence of broadly conical specimens from further north, off the Three kings Islands, presumably reflects local cooling due to upwelling (Marshall, 1981).

Most specimens seen from off the Chatham Islands, including the holotype of *Venustas tigris chathamensis* Dell, 1950, differ from mainland specimens in lacking discrete axial bands and are instead predominantly reddish or yellowish brown with scattered, irregular white spots and streaks (figure 5). Some Chatham Islands shells (e.g., NZOI Q23), however, have axial bands and are essentially similar to specimens from off the South Island and Stewart Island, which commonly have broader bands than northern shells (figure 7). One specimen from the Three Kings Islands (figure 4) is indistinguishable from typical Chatham Islands shells in colour and in density of colour pattern. Although Dell (1950) considered that Chatham Islands specimens differed from mainland shells in having stronger, more persistent nodules, examination of much additional material reveals that sculpture is variable and that the Chatham Islands form cannot be distinguished using this criterion. Accordingly I am unable to justify continued recognition of *V. tigris chathamensis* as a geographic subspecies. Unless *C. tigris* intermittently reaches the Chatham Islands as drifting eggs or larvae from the mainland, it may have reached there along the summit of the Chatham Rise during periods of low sea level, presumably during Pleistocene glaciations.

Three specimens are known from the north-eastern North Island on which the spiral cords remain strong, widely spaced, and nodular throughout (figures 6, 8). The two from Paua, Parengarenga Harbour (figure 6) are also more deeply pigmented and more densely patterned than others living beside them. The third example, from off Cape Karikari (figure 8), differs from all other material examined in that the spiral cords are alternately spotted yellowish brown and white. To some extent the Parengarenga Harbour shells resemble *C. pellucidum* (Valenciennes) in adult facies, whereas that of the Cape Karikari specimen approaches those of both *C. punctulatum* (Martyn) and *C. osbornei* Powell, with all of which they respectively occurred. Although we cannot entirely preclude the possibility, they seem unlikely to be hybrids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because all have the characteristic and highly stable early teleoconch morphology of *C. tigris* (figure 110).

The epithet *tigris* is from the Latin *tigris* ("tiger", third declension feminine) and is a noun in apposition to the generic name *Calliostoma*, hence it is not declinable.

Calliostoma (Maurea) punctulatum (Martyn, 1784)
(Figures 10-18, 28, 32, 128)

Spengler, 1776: 152, pl. 5, figs. 2a, b.
Chemnitz, 1781:26, pl. 161, figs. 1520, 1521.
Trochus punctulatus Martyn, 1784, fig. 36; Philippi, 1855, pl. 15, fig. 7; Reeve, 1862, pl. 16, figs. 95a-d
Trochus diaphanus Gmelin, 1791:3580 (refers to Spengler, 1776: 152, pl. 5, figs. 2a, b; and Chemnitz, 1781, pl. 161, figs. 1520, 1521); Wood, 1825, pl. 29, fig. 99; Quoy & Gaimard, 1834:254, pl. 64, figs. 1-5; Gray, 1842, pl. 40*, figs. 1, 1a; Philippi, 1846:8, pl. 2, figs. 5, 6; Fischer, 1873:43, *Turbo* pl. 10, fig. 2.
Turbo diaphanus—Lamarck, 1822:45.
Ziziphinus punctulatus—Gray 1843:237.
Turbo grandineus Valenciennes, 1846, pl. 4, figs. 4, 4ab; Kiener, 1847, *Turbo* pl. 10, fig. 2.
Zizyphinus punctulatus—Hutton, 1873:39; Hutton, 1880.98 (in part = *C. granti*); Hutton, 1882.165, pl. 7, fig. H; Hutton, 1884:360.
Calliostoma punctulatum—Pilsbry, 1889:334, pl. 65, fig. 75; Suter 1897:280; Suter, 1913:146, pl. 8, fig. 11 (in part = *C. granti*); Bucknill, 1924:32, pl 3, fig. 4 (in part = *C. granti*).
Calliostoma (Mauriella) punctulatum punctulatum—Oliver, 1926:109.
Calliostoma (Mauriella) punctulatum stewartianum Oliver, 1926:109, pl. 10, fig. 1.
Calliostoma (Mauriella) wanganuicum Oliver, 1926:109, pl. 10, fig. 2. **New synonym.**
Venustas (Mucrinops) punctulata punctulata—Finlay, 1926: 361, 371.
Venustas (Mucrinops) punctulata urbanior Finlay, 1926:361, pl. 18, fig. 27; Cernohorsky, 1972:243, fig. 17.
Maurea (Mucrinops) punctulata punctulata—Powell, 1937:64, pl. 13, fig. 3 (in part = *C. granti*).
Calliostoma (Mauriella) punctulatum—Wenz, 1938:282, fig. 601.
Maurea (Mucrinops) punctulata urbanior—Powell, 1937:64
Venustas punctulata punctulata—Dell, 1950:46, fig. 19, 20
Venustas punctulata urbanior—Dell, 1950:47.
Maurea punctulata punctulata—Powell, 1957:88, pl. 13, fig. 3 (in part = *C. granti*).
Maurea punctulata stewartiana—Powell, 1957:88.
Calliostoma (Maurea) punctulata stewartiana—Shikama, 1964, pl. 59, fig. 6.

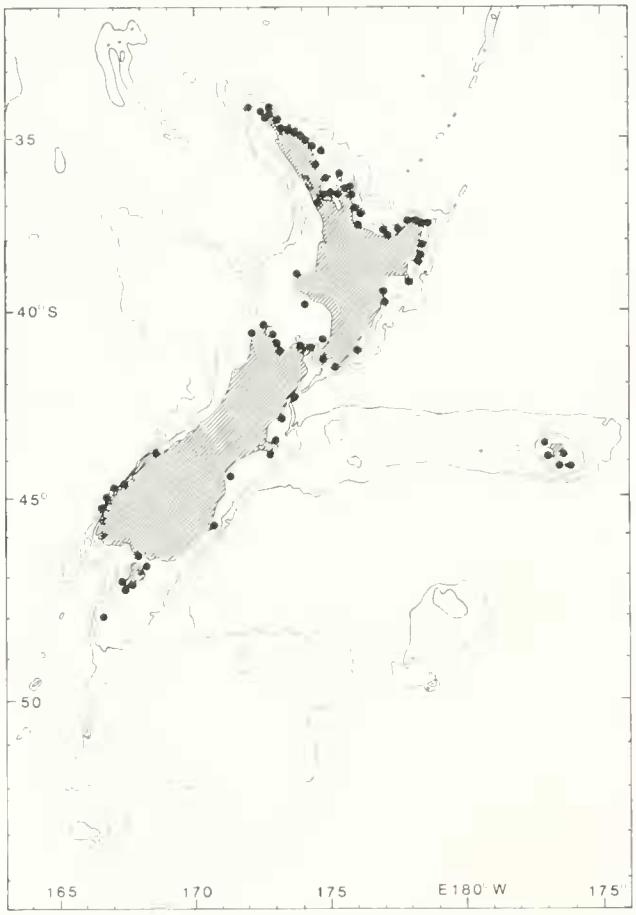

Figure 9. Map of New Zealand region showing distribution of *Calliostoma (Maurea) tigris*. 200 and 1000 meter contours indicated.

Maurea (Mauriella) punctulata punctulata—Fleming, 1966: 38.
Maurea (Mauriella) punctulata stewartiana—Fleming, 1966. 38.
Maurea punctulata—Powell, 1976:84, pl. 20, fig. 3; Powell, 1979:62, pl. 10, fig. 4 (both in part = *C. granti*).
Calliostoma (sensu lato) punctulatum—Beu & Maxwell, 1990: 404.
Calliostoma (sensu lato) wanganuicum—Beu & Maxwell, 1990. 404.
NOT *Venustas punctulata urbanior*—Powell, 1955:55 (*C. granti*).
NOT *Maurea punctulata*—Dell, 1956.46 (*C. granti*).

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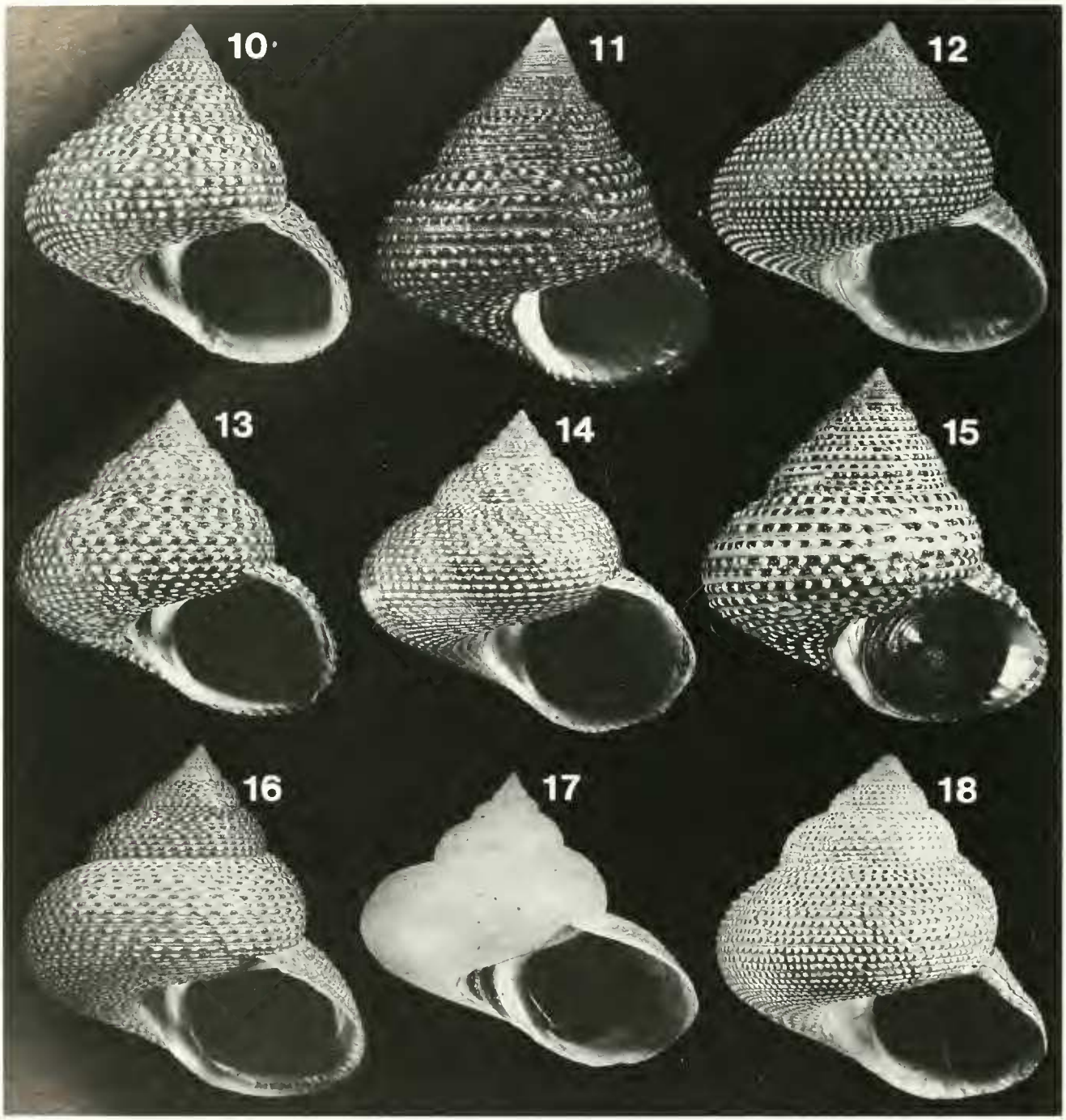
Figures 1-8. *Calliostoma (Maurea) tigris* (Gmelin, 1791). **1.** Off Southwest Island, Three Kings Islands, 22-23 m, MNZ M.75143 (65.5 × 65.0 mm). **2.** Off Poor Knights Islands, 20-30 m, MNZ M 75150 (56.2 × 45 7 mm). **3.** Off Three Kings Islands, craypot, MNZ M.75191, natural size (96.0 × 85.3 mm). **4.** Reef between Great Island and Farmer Rocks, Three Kings Islands, 33 m, MNZ M.84239 (54.0 × 52.3 mm). **5.** Off Southeast Island, Chatham Islands, MNZ M 118120 (54.0 × 51.7 mm). **6.** Paua wharf, Parengarenga Harbour, low tide, possibly hybridized with *C. (M.) pellucidum* (Valenciennes, 1846), MNZ M 118337 (57.0 × 45.0 mm). **7.** Off Ruggedy Island, Stewart Island, 37 m, MNZ M.18996 (70.0 × 68.0 mm). **8.** Off Cape Karikari, 80-120 m, possibly hybridised with *C. (M.) punctulatum* (Martyn, 1784) or *C. (M.) osbornei* Powell, 1926, MNZ M 87026 (36.6 × 32.8 mm).



Figures 10-18. *Calliostoma (Maurea) punctulatum* (Martyn, 1784). **10.** Houhora Heads, low tide, MNZ M.2133 (34.6 × 33.6 mm). **11.** Paua, Parengarenga Harbour, low tide, MNZ M.80482 (32.8 × 29.0 mm). **12.** Northern Pania Reef, Napier, 20m, MNZ M.86724 (34.0 × 35.3 mm). **13, 14.** Barrett's Reef, Wellington Harbour, MNZ M. 45062 (29.0 × 30.4 mm, and 29.0 × 31.2 mm). **15.** Simpson's Rock, Hauraki Gulf, 15-18 m, MNZ M.89971 (31.0 × 29.0 mm). **16.** Timaru breakwater, low tide, MNZ M.5324 (42.4 × 40.8 mm). **17.** Cook Strait, 256-274 m, MNZ M.54911 (32.6 × 38.6 mm). **18.** Mason's Bay, Stewart Island, beach, MNZ M.7200 (51.5 × 47.3 mm).

Type Data: *Trochus punctulatus*: Martyn, 1784: fig. 36, "New Zealand"; *Trochus diaphanus*: Spengler, 1776: pl. 5, figs. 2a, b, "Südsee"; *Turbo grandineus*: Lectotype (here selected) and 1 paralectotype MNHN, New Zealand; *Calliostoma (Mauriella) punctulatum stewartianum*: Holotype MNZ M.879, Stewart Island; *Calliostoma (Mauriella) wanganuicum*: Holotype NZGS TM 4999, mouth of Okehu Stream, Nukumaru Beach, near Wang-

anui (Castlecliffian, Middle Pleistocene); *Venustas (Mucrinops) punctulata urbanior*: Holotype AIM 70824, Foveaux Strait, 37 m.

Other Material Examined: *Fossil*—56 Early-Middle Pleistocene (Castlecliffian) specimens in 22 lots AUG, MNZ, NZGS; *Recent*—1169 specimens in 268 lots MNZ.

Distribution (figure 32)**:** Early Pleistocene to Recent. North, South, and Stewart Islands, living intertidally to 274 m on hard substrata.

Diet: The intestinal tracts of most of the 22 specimens examined (10 localities) contained thecate hydroids (Cnidaria), sand, and sometimes soft tissue of unknown origin (cnidarian?). Two of three specimens examined from Cornwallis, Manukau Harbour contained thecate hydroids, soft tissue, and sand, whereas the intestinal tract of the third animal was packed with calcareous octocoral spicules.

Remarks: This well known, common species is extremely variable in shape, size, thickness, colour, colour pattern, and sculpture (figures 10-18). Recent specimens, however, are readily distinguishable from closely related taxa (see below) by features of the early teleoconch, notably the pronounced whorl angulation at P2, the relatively weak axial costae, and the slow enlargement of S3 (figure 28). Shells range in shape from narrowly to broadly conical (height/diameter ratio 0.87-1.13; sa 65-96°, mean 84.7°, SD 5.83, $n = 74$). Specimens from Parengarenga Harbour are the most narrowly conical, with spire angles ranging from 65° to 72° (figure 11). Specimens taken alive from Cook Strait at 256-274 m (figure 17), the deepest record for the species, are the most broadly conical (sa 86-96°). The latter specimens, and some from off East Otago, Stewart Island, and Foveaux Strait, are unusual in having a callous-filled umbilical depression, the umbilicus being completely invaded by the inner lip in other Recent material. Mature specimens are usually characterised by contraction and descent of the last part of the last whorl and range from 18 to 51 (est.) mm in height, the smallest adult specimens examined occurring off Cape Maria van Diemen, and the largest at Stewart Island in shallow depths, mainly as beach shells (figure 18). Shell thickness varies by a factor of 2 or more. Thicker specimens tend to predominate in exposed situations, and most are more darkly pigmented with fewer and coarser spiral cords than shells from deeper water. Colour ranges from dark reddish to pale yellowish brown, the spirals darker, the nodules either predominantly white or roughly alternating brown and white. Specimens from the northern North Island tend to be more darkly pigmented than material from the southern South Island. Spiral cords are multiplied by repeated intercalation of secondaries and tertiaries at variable stages of growth and range in number from 6 to 25 on the second-to-last whorl of mature specimens. There is a strong correlation between the strength of sculpture and the number of spiral cords on later whorls. Coarsely sculptured specimens with strong primary and secondary spirals tend to develop fewer secondary spirals, whereas more finely sculptured specimens tend to develop more numerous tertiary spirals that enlarge more rapidly to resemble the adjacent spirals. Coarsely sculptured specimens tend to predominate in the northern North Island, finely sculptured forms in the southern South Island and in deep-living populations. A notable exception is the occurrence of a pale, thin, finely sculptured form at low tide in Manukau Harbour, presumably in response to some local environmental factor. In most specimens from north of Cape Egmont and north of East Cape, including Manukau Harbour, S3 commences about midway between P3 and P4, whereas in most specimens from the south, especially the southern South Island and Stewart Island, S3 commences close beside P4. Although samples from the southern North Island and northern South Island often comprise one form or the other, both forms frequently occur together and completely intergrade in several large samples (e.g., MNZ M.32569, M.44051, M.45062, M.54911). Southern forms have been treated as geographic subspecies (*stewartiana* Oliver, *urbanior* Finlay) of the coarser nominate northern forms, but in fact there is complete mosaic intergradation in all extremes of shell morphology both within and between populations, and it is quite impossible to define regional subspecies.

In the Wanganui basin, *C. punctulatum* first appears in the Butlers Shell Conglomerate (early Castlecliffian, Early Pleistocene) (AU1047, AUG; GS4109, NZGS) (Turner & Kamp, 1990). An imperfectly preserved shell (MNZ M.95387) from an Early Pleistocene (late Nukumaruan) horizon exposed in a cutting on White Rock Road, south of Hautotara Bridge, Martinborough appears to represent this species. A worn, incomplete specimen from a Middle Pliocene (Waipipian) horizon in the Waipara Gorge (GS4946, NZGS) is also similar but cannot be identified with certainty. All specimens from the Butlers Shell Conglomerate and from between it and the younger Kaikokopu Shell Grit (GS4064, 4075, 4134, 4163, 4168, NZGS) (late Castlecliffian, Early Pleistocene), including the holotype of *C. wanganuicum*, differ from Recent specimens in having stronger axial costae on the early teleoconch and in the earlier appearance and more rapid enlargement of S3 (appearing at shell diameter of 1.9-3.4 mm, mean 2.6 mm, $n = 11$ as against 3.1-8.0 mm, mean 4.72 mm, $n = 24$), which is highly conspicuous on early whorls as a suprasutural cord close beside P4. In this character, these specimens bear some resemblance to the Waipipian-Recent species *C. granti* (Powell) but differ in being more broadly conical and by having more strongly convex whorls as in Recent specimens of *C. punctulatum*. S3 appears midway between P3 and P4 in most Recent specimens of *C. punctulatum*, though as already stated, its origination position may vary from median to submedian in some populations. Specimens from the Kupe Formation (late Castlecliffian, Middle Pleistocene) and overlying formations (GS4041, 4052, 4120, 4121, 4122, 4175, 4186, NZGS) are morphologically intermediate between earlier and Recent forms.

Moreover, the fossils are as variable in shape, thickness, nodule size, and strength and number of spiral cords as in Recent material, and there is intergradation between extremes within horizons. Accordingly it seems impossible to justify recognition of *C. wanganuicum* as a distinct species or chronosubspecies. Three specimens from the Butlers Shell Conglomerate (GS4109, NZGS; AU1047, AUG) are unusual in having the umbilicus wide open instead of fully closed through invasion by the inner lip. One of the two umbilicate specimens from GS4109 has the umbilicus considerably narrower than in the other and is thus intermediate between umbilicate and anomphalous forms from the same sample, which are otherwise indistinguishable.

Calliostoma punctulatum is notable for its absence from the Chatham Islands and the subantarctic islands, including The Snares, and all specimens hitherto so identified from there are *C. granti* (see below). Of yet greater interest is its absence from the Three Kings Islands, some 60 km north of Cape Maria van Diemen, where there are two superficially similar species with closer relationship to *C. granti* (see below). Its absence from this island group may be due to a locally unfavourable environment, either at present or when sea levels were low enough for the species potentially to have reached them, for example during Pleistocene glaciations. As with other local calliostomatids that show pronounced clinal variation, it is likely that *C. punctulatum* has a drifting larval stage of short duration.

Calliostoma (Maurea) granti (Powell, 1931)
(Figures 19-27, 29, 33, 129)

Zizyphinus punctulatus—Hutton, 1880:98 (in part not Martyn, 1784).
Calliostoma punctulatum—Suter, 1913:146 (in part).
Maurea (Mucrinops) granti Powell, 1931:97, pl. 13, figs. 34,35.
Maurea (Mucrinops) punctulata punctulata—Powell, 1937:64 (in part).
Maurea (Mucrinops) punctulata ampla Powell, 1939:229, pl. 50, fig. 6. **New synonym**
Venustas punctulata ampla—Dell, 1950:47.
Venustas punctulata (?) n.subsp. Dell, 1950:47.
Venustas punctulata multigemmata Powell, 1952:173, pl. 35, figs. 2,3. **New synonym**.
Venustas punctulata urbanior—Powell, 1955:55 (not Finlay, 1926).
Maurea punctulata—Dell, 1956:46 (not Martyn, 1784).
Maurea punctulata punctulata—Powell, 1957:88 (in part).
Maurea punctulata ampla—Powell, 1957:88.
Maurea punctulata multigemmata—Powell, 1957:88.
Maurea (Mauriella) granti—Fleming, 1966:38.
Maurea (Mauriella) osborni—Fleming, 1966:38 (not Powell, 1926).
Maurea punctulata—Powell, 1976:84, Powell, 1979:62 (in part).
Maurea multigemmata—Powell, 1976:84; Powell, 1979:62, pl 10, fig. 6, pl. 19, fig. 8.
Maurea blackii [*sic*]—Horikoshi, 1989, pl. 4, fig. 12 (not Powell, 1950).
Calliostoma (sensu lato) granti—Beu & Maxwell, 1990:404.

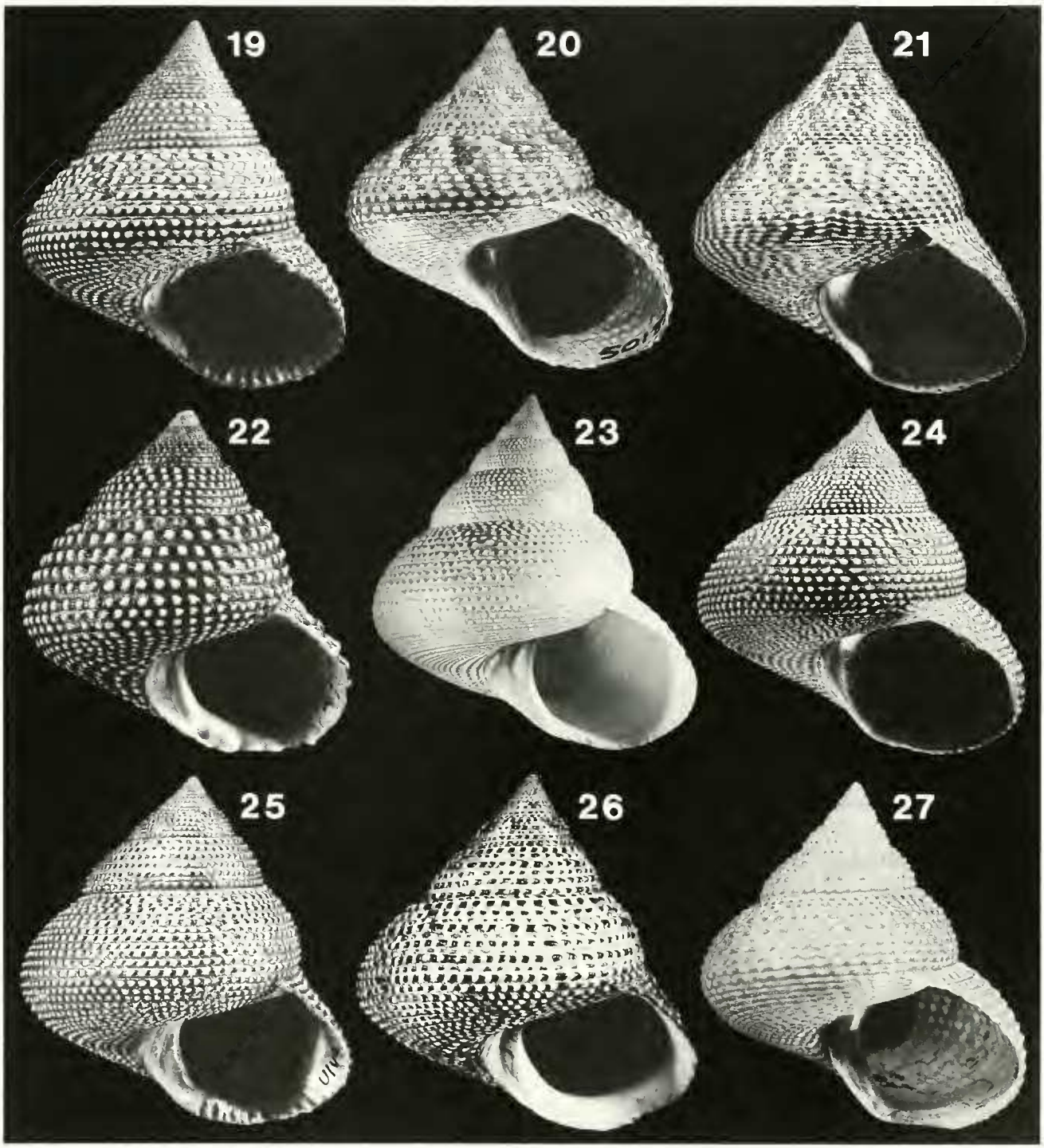
Type Data: *Maurea granti*: Holotype AIM 70449, Waihi Beach, Hawera (Waipipian, Middle Pliocene); *Maurea punctulata ampla*: Holotype AIM 70450, Masons Bay, Stewart Island; *Venustas punctulata multigemmata*: Holotype AIM 71185, off East Otago, 91-128 m.

Other Material Examined: *Fossil*—GS4253, Upper Waipipi Shellbed, Waverley Beach, S. Taranaki (Waipipian, Middle Pliocene) (3 NZGS); GS4949, c. 200 m SE of north end of Greenwood's Bridge, left bank, lower Waipara Gorge, map ref. N34/922867 (f6180) (Waipipian) (1 NZGS); GS5237, 724 m N of Trig Turangatairoa, on main Taihape/Waiouru Road, map ref. T21/429771 (f8503) (probably Waipipian; A.G. Beu, per.comm.); GS4013, Tainui Shellbed, Wanganui (late Castlecliffian, Late Pleistocene) (1 AUG); GS4025, Pinnacle Sand, Wanganui (late Castlecliffian) (1 NZGS). *Recent*—508 specimens in 124 lots MNZ, and 4 specimens in 2 lots NZOI.

Distribution (figure 33): Middle Pliocene (Waipipian) to Recent. North Island south of East Cape and Cape Egmont, and South, Stewart, Snares, Auckland, Campbell, and Chatham islands, living from low-tide level to 220 m on hard substrata.

Diet: From gut contents (pers.obs.) and field observations (M.H.B. O'Neill, pers. comm.), *C. granti* feeds principally on Cnidaria, including thecate hydroids and anemones, as well as ascidians.

Remarks: I am unable to detect any constant differences between Waipipian (Middle Pliocene) specimens of *Calliostoma granti* and the Recent forms named *Maurea punctulata ampla* and *Venustas punctulata multigemmata*. *Maurea punctulata ampla* was originally separated from the sympatric(!) "subspecies" *M. punctulata urbanior* Finlay, 1926 (*i.e.*, *C. punctulatum* Martyn, 1784) on the basis of the larger, more elevated shell, that has 9-12 instead of 12 equally developed spiral cords. *Venustus punctulata multigemmata* was separated from *M. punctulata ampla* because of its more lightly built shell and finer, more numerous spiral cords. Study of many times the number of specimens available when these taxa were proposed, however, reveals that *M. punctulata ampla* and *V. punctulata multigemmata* are based on forms of a single polymorphic species (*i.e.*, *C. granti*) that occurs sympatrically with *C. punctulatum* from East Cape southward to Stewart Island. It transpires that neither *M. punctulata ampla* nor *V. punctulata multigemmata* can be distinguished from *C. punctulatum* using the characters cited in the original descriptions. Like *C. punctulatum*, *C. granti* has considerable variation in shell size and shape, both within populations and clinally, and in the strongly correlated number and relative sizes of the spiral cords on the last two adult whorls. Beach shells and specimens collected intertidally (figure 22) tend to be thick and darkly pigmented with few, strong, strongly nodular spiral cords, whereas specimens from deeper water (figures 20,23) tend to be thin and



Figures 19-27. *Calliostoma (Maurea) granti* (Powell, 1931). **19.** Boil Reef, Napier, 10-20 m, MNZ M 84224 (32.0 × 28.5 mm). **20.** Off Wanganui, 82 m, MNZ M.50181 (21.4 × 22.0 mm). **21.** Westhaven Inlet, low tide, MNZ M.81531 (38.4 × 35.1 mm). **22.** Kahurangi Point, north-west Nelson, beach, MNZ M.23101 (28.0 × 27.4 mm). **23.** Off Oamaru, c. 100 m, MNZ M.102602 (44.6 × 41.4 mm). **24.** Off Seymour Island, Dusky Sound, 24 m, MNZ M.80476 (36.0 × 34.8 mm). **25.** Paterson Inlet, Stewart Island, beach, MNZ M 19119 (45.6 × 42.0 mm). **26.** Point Munning, Chatham Islands, 12 m, MNZ M 111927 (41.0 × 38.1 mm). **27.** Off Auckland Islands, 104 m, NZOI D80 (24.0 × 23.8 mm).

lightly pigmented (or white), with finer, more finely nodular, more numerous spiral cords: the former include the type material of *M. punctulata ampla*, the latter *V. punctulata multigemmata* and *C. granti*. There is complete mosaic intergradation between these extremes in the Recent material.

Although *C. granti* and *C. punctulatum* are similar in gross facies, there are nevertheless marked and constant differences in the shape and sculpture of the early teleoconch whorls (figures 28, 29). *Calliostoma granti* differs from *C. punctulatum* in the following features: (1) the more rapid development of S3, which enlarges to resemble the adjacent primaries at least a full whorl earlier; (2) the stronger axial riblets, which persist over one or two additional whorls; (3) the more weakly convex and more slowly expanding early teleoconch whorls (*i.e.*, narrower early spire angle); and (4) by comparison with *C. punctulata* from within its range, the early teleoconch is evenly conical in shape instead of coeloconoid, although in allopatric *C. punctulatum* from the far north of its range, the spire is typically evenly but yet more broadly conical. Adult teleoconch whorls are typically more weakly convex than in *C. punctulatum*, although they tend to become as strongly convex in deep-living populations (figures 20, 23). The sides of the foot are considerably more finely pustulose in *C. granti* than in *C. punctulatum*.

The holotype of *C. granti* (Powell, 1931, pl.13, figs. 34, 35) is more narrowly and evenly conical than any known Recent specimen (sa 67°, instead of 70-87°, mean 78°, $n = 31$), though all other fossils resemble Recent shells in shape. A coeval specimen (GS4949, NZGS) is substantially larger than the largest known Recent shell (diameter 61 mm, as against 49 mm). All of the fossils are indistinguishable from Recent specimens in sculpture. Because I am unable to detect any character or character state, single or combined, that would enable separation of Recent and fossil specimens, they are all interpreted as forms of a single polymorphic species. Should the Recent form prove to be specifically distinct when additional, better-preserved Waipipian material is available, Powell's *amplum* will be available for the Recent form.

All specimens seen from the Chatham Islands (figure 26) and beach shells from the Auckland Islands and Campbell Island are particularly thick and heavily sculptured. Two specimens from 104 m depth off the Auckland Islands (NZOI D80, figure 27) are thin and finely sculptured and resemble topotypes of the *multigemmata* form. Unless the species has a planktonic larval stage of sufficient duration for transportation to these islands from the mainland by ocean currents, it probably had a more or less continuous distribution between them during periods of lowered sea level, presumably during the Pliocene or Pleistocene. That sea temperature may be a factor restricting its northernmost limit to East Cape is suggested by the occurrence of two closely related species (*C. jamiesoni* new species and *C. gibbsorum* new species) off the Three Kings Islands where sea temperature is cooler than off adjacent Northland due to local upwelling (see *C. tigris*).

Calliostoma granti resembles *C. osbornei* Powell, 1926 in the rapid enlargement of S3 relative to S1 and S2, but the latter two spirals enlarge more slowly in *C. osbornei*, and *C. granti* has a weak but distinct angulation at P2 on the early teleoconch (figures 29, 31). By comparison with specimens of *C. osbornei* from north of Cape Egmont, the spiral cords on the early teleoconch whorls in *C. granti* are yellowish brown with white nodules instead of being predominantly uniform white, whereas the spiral interspaces are pale buff instead of orange or yellowish to reddish brown. *Calliostoma granti* differs further from *C. osbornei* by having stronger, more numerous axial costae on the early teleoconch whorls, especially on the 4th and early 5th whorls, which are also more strongly convex.

Specimens of *C. osbornei* from off the south-western North Island (figure 41) differ from most northern shells in being as broadly conical as *C. granti* (sa 75-82°, mean 78°), and in that the spiral cords on the early teleoconch whorls are reddish brown between white nodules. Specimens of *C. osbornei* from these southern populations differ from coexisting *C. granti* by having more weakly convex 4th and 5th teleoconch whorls and by having much more deeply and evenly pigmented spiral cords on the early teleoconch whorls.

Calliostoma (Maurea) benthicola (Dell, 1950)
(Figures 33, 34)

Venustas benthicola Dell, 1950:47, fig. 21.
Maurea benthicola—Powell, 1957:88; Powell, 1979:62.

Type Data: Holotype MNZ M.4728, 41°21'S, 175°00'E, Mernoo Bank, western Chatham Rise, 95 m.

Other Material Examined: 22 specimens in 5 lots MNZ.

Distribution (figure 33): Endemic to Mernoo Bank, western Chatham Rise, 75-129 m, taken alive at 95-129 m on shell substratum.

Remarks: *Calliostoma benthicola* differs from *C. granti* by having weaker nodules, and by being white with broad, reddish brown bands on the spiral cords after the fifth teleoconch whorl. It is otherwise extremely similar, particularly to specimens from equivalent depths off Otago, and there can be little doubt that the two forms are very closely related.

Calliostoma benthicola appears to be endemic to the Mernoo Bank and is absent from hundreds of dredge and trawl stations from the adjacent Chatham Rise and off Banks Peninsula and Kaikoura. Mernoo Bank rises from depths exceeding 450 m, which are considerably greater than the known lower limit for living *C. granti* (220 m). It seems likely that *C. benthicola* diverged from *C. granti* stock that was isolated on the Mernoo Bank (and the Chatham Islands), perhaps following a period of lowered sea level during the Pleistocene when Mernoo Bank was an island and the Chatham Rise was sufficiently

close to the surface for icebergs to strand on its summit (Cullen, 1962). *Calliostoma benthicola* appears to be an example of a species that arose from a small, isolated population that carried only a fraction of the total genetic material of the parent population (founder effect of Mayr, 1963). This explanation probably accounts for the origin of the distinctive buccinid *Cominella olsoni* (Dell, 1956), which is also endemic to the Mernoo Bank and is probably derived from *Cominella nassoides* (Reeve, 1846), forms of which occur to the east off Kaikoura and to the west off the Chatham Islands.

Calliostoma (Maurea) jamiesoni Marshall, new species (Figures 30, 33, 36)

Description: Shell up to 33 mm high, higher than broad, spire gently cyrtoconoid, spire angle 69-78° (mean 73°, $n = 20$), stout, glossy, anomphalous. Colour of protoconch and 1st 4 teleoconch whorls uniform yellowish to orange brown. Subsequent whorls yellowish to orange brown, spiral cords reddish brown, nodules white or buff white. Protoconch 400 μm wide, sculptured with fine threads that enclose hexagonal spaces. Teleoconch of up to 8 whorls, last adult whorl contracted at maturity. Spire whorls convex, periphery rounded, base weakly convex. First 0.25 whorl delineated by a growth scar, with 2 axial riblets and fine spiral threads. Subsequent whorls sculptured with spiral cords, rounded nodules, and axial riblets; axials strong on 1st 3 whorls, weakening on 4th whorl, becoming obsolete on 5th whorl. Spiral cords rounded, narrow, with broad interspaces on 1st 3 whorls, cords broadening and interspaces narrowing on 4th whorl. Spiral cords numbering 7 or 8 on penultimate whorl and 8 or 9 on last adult whorl. P1-4 commencing immediately, P4 partly covered by succeeding whorls, becoming fully exposed on penultimate whorl by descent of last adult whorl. S1-3 appearing late on 2nd or on 3rd whorl, gradually enlarging to resemble adjacent primaries (S3 absent in 1 specimen). A subsutural spiral appears on penultimate or last whorl in most mature specimens and gradually enlarges to resemble primaries; 1 or more additional spirals intercalate on last adult whorl. Spiral interspaces with collabral growth lines, most interspaces on later spire whorls with up to 4 fine spiral threads. Columella thick. Aperture subcircular. Outer lip thin at rim, thickened within, inner lip spreading onto columella, parietal glaze very thin.

Type Data: Holotype MNZ M.75141 (height 28.5 mm, width 26.0 mm), off Prince's Rocks, Three Kings Is., alive, 15 m, 2 December 1983, scuba, G.S. Hardy and A.L. Stewart. Paratypes (26 MNZ), all from off Three Kings Is.: Off Three Kings Is., alive, craypot, A.D. Howell (1); Three Kings Is., alive, 5 m, March 1982, scuba, K. Burch (2); Tasman Bay, Great King I., alive, 9 m, 19 February 1974, scuba, A.N. Baker & J. Moreland (1); South West I., alive, 22-23 m, 2 December 1983, scuba, G.S. Hardy & A.L. Stewart (3); S side South West I., alive, 27 m, 12 February 1986, scuba, G.S. Hardy (1); reef between Great King I. and Farmer Rocks, dead, 33 m, 17 February 1986, scuba, G.S. Hardy (15); North West Bay, Great King I., alive, 30 m, 14 February 1986, scuba, G.S. Hardy (1); N. face Hinemoa I., 24 m, 11 February 1986, alive, 3-5 m, 12 February 1986, scuba, G.S. Hardy (2).

Other Material Examined: 129 specimens from 6 stations off Three Kings Is., MNZ, mostly immature.

Distribution (figure 33): Endemic to Three Kings Islands, 5-128 m, taken alive at 5-55 m on rock.

Diet: Intestinal tracts contained thecate hydroids (Cnidaria) and much indeterminate organic matter.

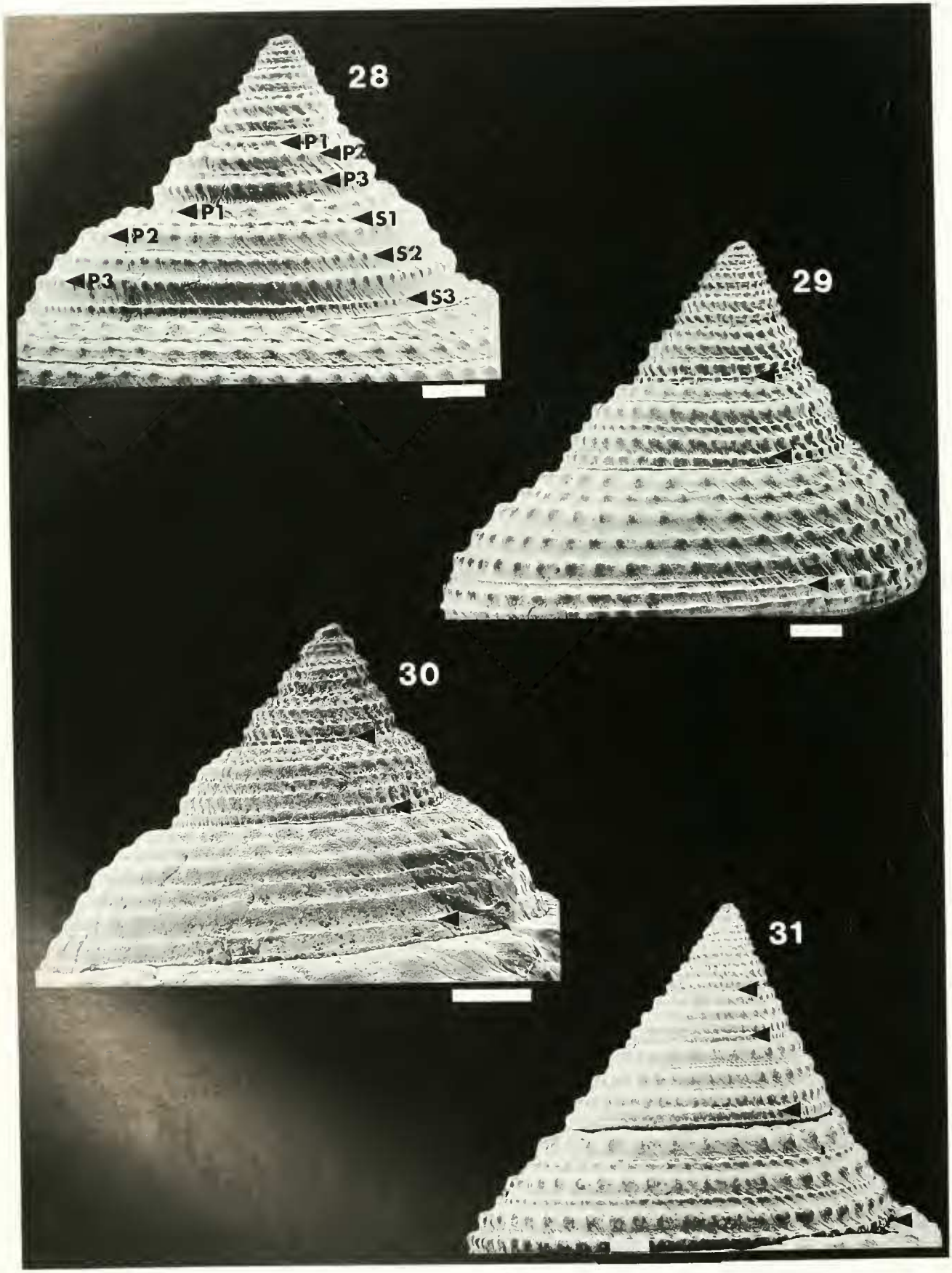
Remarks: *Calliostoma jamiesoni* is superficially similar to *C. punctulatum*, *C. granti*, *C. benthicola*, and broad forms of *C. osbornei*, but most closely resembles *C. granti* and *C. benthicola* in development of the teleoconch sculpture. It differs from all of them, however, in the uniform coloration of the protoconch and early teleoconch whorls and in the low relief of the spiral cords and nodules on the fourth to sixth teleoconch whorls (figures 28-31). The spire tends to be more strongly cyrtoconoid and the body whorl more contracted at maturity. It differs further from *C. punctulatum*, *C. granti*, and *C. benthicola* in the early appearance and more rapid enlargement of the secondary spirals, especially S3, and from *C. osbornei* in the roughly simultaneous appearance and rather even rate of enlargement of S2 and S3 and the more strongly convex whorls.

Judging from development of the teleoconch sculpture, *C. jamiesoni* is more closely related to *C. granti*, *C. benthicola*,and *C. gibbsorum* new species (see below) than to the superficially similar species *C. punctulatum* and *C. osbornei*.

Etymology: After Peter Jamieson (Wellington), who sought and provided much material for this revision, and as an appreciation for his fostering of New Zealand malacology in general, both amateur and professional.

Calliostoma (Maurea) gibbsorum Marshall, new species (Figures 33, 35, 109, 130)

Description: Shell up to 28.5 mm (est.) high, higher than broad, spire angle 53-76°, stout, glossy, anomphalous. Colour of protoconch and 1st teleoconch whorl buff or white. Next 2 whorls buff with yellowish brown spirals and white nodules and axials. Subsequent whorls yellowish to orange brown, nodules more lightly pigmented or white, spirals more darkly pigmented. Protoconch 370-400 μm wide, sculptured with fine threads that enclose hexagonal spaces. Teleoconch of up to 8.2 whorls. Spire whorls weakly convex or almost flat, periphery rounded or subangulate, base weakly convex. First 0.25 whorl delineated by a growth scar, with 2 axial riblets and fine spiral threads. Subsequent whorls sculptured with spiral cords, rounded nodules, and axial riblets, the axials strong on 1st 4 whorls, weakening and becoming obsolete on 5th whorl. Spiral cords rounded, narrow with broader


28
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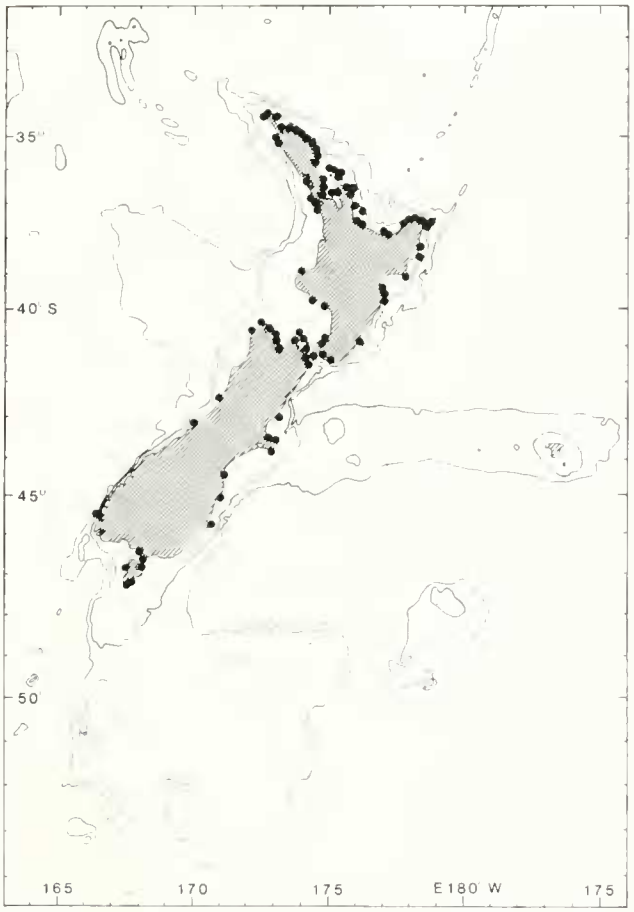

Figure 32. Map of New Zealand region showing distribution of *Calliostoma (Maurea) punctulatum*. 200 and 1000 meter contours indicated.

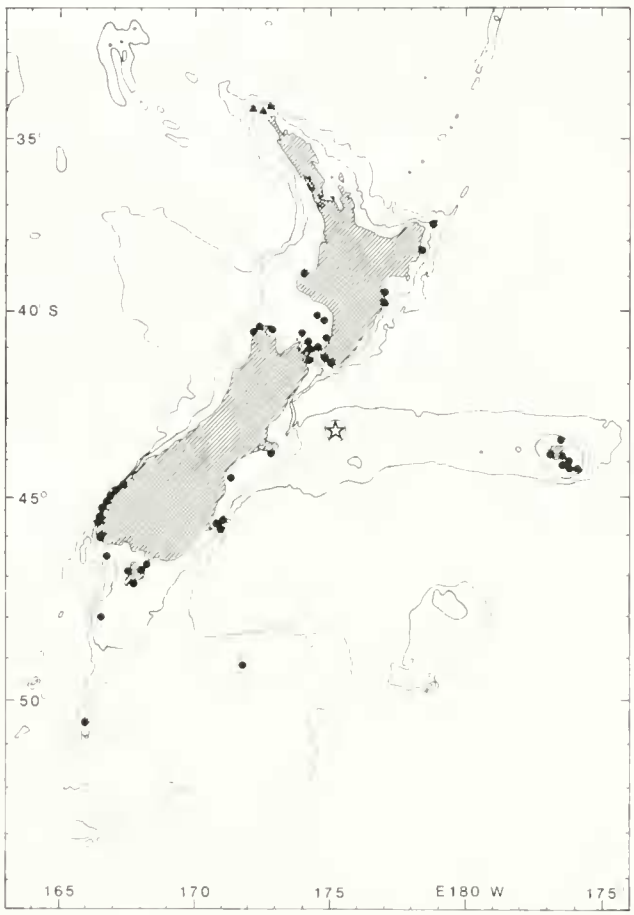

Figure 33. Map of New Zealand region showing distribution of *Calliostoma (Maurea) granti* (circle), *C. (M.) benthicola* (star), and collectively *C. (M.) gibbsorum*, *C. (M.) jamiesoni*, and *C. (M.) regale* (triangle). 200 and 1000 meter contours indicated

interspaces on 1st 4 whorls, spirals broadening and interspaces narrowing on 5th whorl. Spiral cords numbering 7 on adult penultimate whorl and 11 on base. P1- 4 commencing immediately, P4 almost or entirely covered by succeeding whorls throughout or (as in holotype) becoming entirely exposed at suture from as early as 5th whorl. S1-S3 gradually enlarging to resemble adjacent primaries. Additional spirals intercalated on penultimate and last adult whorls of an exceptionally large specimen. Spiral interspaces with collabral growth lines, a few spiral threads in some specimens. Aperture subquadrate to subcircular. Outer lip thin at rim, thickened within, inner lip spreading onto thick columella, parietal glaze thin.

Type Data: Holotype MNZ M.35456 (height 16.8 mm, width 12.5 mm), BS 389, between Palmer Rocks and South East I., Three Kings Is., dead, 82 m, 18 February 1974, r.v. *Acheron*. Paratypes (3 MNZ): BS 893 (0639), 33°59.9'S, 171°45.3'E, Middlesex Bank, NW of Three Kings Is., dead, 186-196 m, 31 January 1981, r.v. *Tan-*

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Figures 28-31. Early teleoconch whorls. Primary (P) and secondary (S) spiral cords indicated. **Figure 28.** *Calliostoma (Maurea) punctulatum* (Martyn, 1784). Cook Strait, 256-274 m, MNZ M.54911. Note late appearance and slow enlargement of S3, weak axial sculpture, and broad, strongly convex 5th teleoconch whorl. **Figure 29.** *Calliostoma (Maurea) granti* (Powell, 1931). Off Stephens Island, Cook Strait, 183-187 m, MNZ M.50266. Note early appearance and rapid enlargement of S3 (arrowed), strong axial sculpture, and narrow, weakly convex 5th teleoconch whorl. **Figure 30.** *Calliostoma (Maurea) jamiesoni* Marshall, new species. Off West Island, Three Kings Islands, 37 m, MNZ M.80656. Note closer similarity of sculpture to that of *C. (M.) granti* (**29**) than to *C. (M.) punctulatum* (**28**), S3 arrowed. **Figure 31.** *Calliostoma (Maurea) osbornei* Powell, 1926. Off Cape Maria Van Diemen, 38-43 m, MNZ M.74665. Note late appearance of S1 and S2, early appearance and very rapid enlargement of S3 (arrowed), evenly conical outline, and flattened whorls. Scale bars = 1 mm.

garoa (1 BS 921, *Elingamite* wreck, off West Island, Three Kings Is., dead, 37 m, 16 March 1981, suction dredge, K. Tarlton (1); off Three Kings Is., alive, craypot, A.D. Howell (1).

Other Material Examined: 60 specimens from 13 stations off Three Kings Islands, MNZ, mostly juveniles.

Distribution (figure 33): Off Three Kings Islands, 33-805 m, taken alive at 102 m and probably living as shallow as about 30 m on rugged bryozoan/shell substratum with corals, sponges, and gorgonians. Probably endemic.

Diet: Unknown.

Remarks: *Calliostoma gibbsorum* is superficially similar to *C. jamiesoni*, *C. granti*, *C. benthicola*, and to a lesser degree, *C. punctulatum*, and *C. osbornei*. It closely resembles *C. jamiesoni*, *C. granti*, and *C. benthicola* in development of the spiral teleoconch sculpture, specifically in the more or less simultaneous origin and even rate of development of S1-3. Compared with the sympatric species *C. jamiesoni*, it differs constantly in colour and colour pattern (especially when immature—see descriptions); in having stronger, more crisply defined spirals and nodules after the third teleoconch whorl; in having narrower, more numerous spiral cords on the base (11 instead of 8 or 9); and in the shape of teleoconch whorls, which expand more slowly and are more weakly convex after the fourth whorl. Compared with the allopatric species *C. granti* and *C. benthicola*, development of teleoconch sculpture is entirely more rapid, S2 and S3 appearing and enlarging to resemble the primaries a half to a full whorl earlier. Moreover, the nodules are more rounded, and the axial sculpture persists for longer and is stronger, especially on the fourth and early fifth whorls. It differs from the allopatric species *C. punctulatum* in the earlier appearance and more rapid enlargement of the secondary spirals (especially S3), the stronger, more persistent axial costae, and the more weakly convex whorls. From the sympatric species *C. osbornei* it differs in numerous details of colour, colour pattern, and sculpture, most obviously in the more or less simultaneous appearance of S2 and S3. For further remarks see *C. jamiesoni* (above).

Etymology: After David and Sharon Gibbs (Auckland) who provided much valuable material and as an appreciation for their fostering of amateur and professional malacology in New Zealand.

Calliostoma (Maurea) osbornei Powell, 1926
(Figures 31, 37-39, 41, 43, 131)

Calliostoma osbornei Powell, 1926:591, pl. 102, fig. 1, 2.
Calliostoma (Mauriella) osbornei—Oliver, 1926:110.
Venustas (Mucrinops) osbornei—Finlay, 1926:361, 371.
Maurea (Mucrinops) osbornei—Powell, 1937:64, pl. 13, fig. 4.
Venustas osbornei—Dell, 1950:47.
Maurea osbornei—Powell, 1957:88, pl. 13, fig. 4, Powell, 1979: 62, pl. 10, fig. 5.
Maurea (Mauriella) osbornei—Fleming, 1966:38.

Type Data: Holotype AIM 72037, off Cape Barrier, Great Barrier I., c. 49 m, from fish stomach.

Other Material Examined: *Fossil*—GS4253, Upper Waipipi Shellbed, Waverley Beach, south Taranaki (Waipipian, Middle Pliocene) (1 NZGS). *Recent*—167 specimens in 45 lots MNZ.

Distribution (figure 43): Middle Pliocene (Waipipian) to Recent, Three Kings Islands southward to off Kapiti Island, southern North Island (34°08.5'S-40°50'S), 0-102 m, living at 12-93 m on the sponge *Ancorina alata* Dendy, 1924 on rocky ground.

Diet: *Ancorina alata* Dendy, 1924 (Porifera : Stellettidae).

Remarks: *Calliostoma osbornei* bears a strong superficial resemblance to *C. punctulatum* and *C. granti*. From *C. punctulatum* it differs in numerous details, most notably the rapid enlargement of S3 and the relatively slow enlargement of S1 and S2 (figure 31). Other differences include the more weakly convex whorls, stronger nodules on the early teleoconch, and the lack of a prominent angulation at P2 on the third-fifth teleoconch whorls. Among differences in colour and colour pattern, the most notable are on the first four whorls, which are typically orange with white spiral cords and nodules instead of being predominantly white with reddish or yellowish brown spiral cords and white or alternately spotted nodules. The only known exceptions are specimens from off New Plymouth (figure 41), Wanganui and Kapiti Island at the extreme southern limit of its range, which resemble *C. punctulatum* in colour pattern. Most specimens of *C. osbornei* are more narrowly conical than *C. punctulatum*, though some shells may be as broadly conical, especially those from the extreme south of its range (sa in southern material 50-82°, mean 66°, S.D. 7.29, $n = 52$, as against 65-96°, mean 85°, S.D. 5.83, $n = 64$). Despite the similarity in shape, broad specimens of *C. osbornei* are readily separable from *C. punctulatum* by the characteristic teleoconch sculpture. The Middle Pliocene (Waipipian) specimen lacks the early spire whorls but is otherwise well preserved and indistinguishable from Recent material. Judging from its present restricted northern distribution (figure 43) and rarity south of Cape Egmont, the lack of fossils from overlying horizons in the Wanganui section may be related to sea temperatures, which were cooler after the Waipipian (Beu, 1966). The present distribution of *C. osbornei* is not entirely determined by that of its food, the grey sponge, *Anchorina alata*, which ranges at least as far south as Banks Peninsula (M.H.B. O'Neill, pers. comm.).

Calliostoma (Maurea) regale Marshall, new species
(Figures 33, 40, 111, 132)

Description: Shell up to 12.6 mm high, glossy, of moderate thickness; spire narrowly and rather evenly conical, 1.50-1.87 × higher than aperture in adults; spire angle 54-63°, anomphalous. Colour of tip of apical fold yel-

lowish brown, rest of protoconch white. Most fresh specimens pale yellowish brown between nodules on P2 and P3 on 2nd and 3rd teleoconch whorls, some specimens with addition of a sub- and/or suprasutural band of dull olive that persists onto 4th whorl. First 2 whorls typically with a pinkish flush. Fresh juveniles with pale yellowish brown spots on spiral cords on innermost third of base. Shell elsewhere rather uniform pale buff white. Protoconch 370 μm wide, sculptured with a network of fine threads that enclose hexagonal spaces, terminal varix strong, rounded. Teleoconch of up to 7.25 whorls. First few whorls rather strongly convex, angulated at P2 and P3, subsequent whorls very weakly convex. Periphery rounded at maturity, base more or less flat. First quarter whorl delineated by a growth scar, with a strong, rounded axial varix and fine spiral threads. Subsequent spire whorls encircled by prominent spiral cords with rounded nodules, the spirals multiplying by intercalation of secondaries and tertiaries that enlarge to resemble primaries. Nodules evenly developed on each spiral, occasionally becoming very weak after 5th whorl on spirals other than P1. P1 commencing late on 2nd or early on 3rd whorl, gradually enlarging to resemble P2 and P3, which commence immediately after growth scar on 1st whorl. P4 covered by succeeding whorls, becoming fully exposed on penultimate whorl by descent of last adult whorl, nodular on last adult whorl, smooth before it. S1 commencing from early on 3rd whorl to start of 6th whorl, S2 commencing from late on 2nd whorl to midway through 3rd whorl, S3 commencing from late on 3rd whorl to midway through 4th whorl. In adults a tertiary spiral intercalates on penultimate whorl, where the total of 8 spirals includes emergent P4. Additional tertiaries intercalate on last adult whorl. Axial riblets strong on 1st 3 whorls, weakening on 4th and becoming obsolete on 5th whorl. Interspace of P3 and P4 on 1st 4 whorls with numerous fine, close, crisp, secondary axial riblets that become obsolete on succeeding whorl. Basal spirals multiplying by intercalation of a few secondaries to number about 10 in adults; interspaces about as wide as each spiral or narrower, sculptured with fine collabral growth lines; spirals weak and smooth in immature specimens, becoming stronger and nodular with increasing size, rarely more or less smooth in adults. Outer basal spirals resembling spire spirals, inner spirals stronger and more strongly nodular. Aperture subquadrate, strongly thickened within and immediately behind apertural rim in adults, especially at base and columella.

Type Data: Holotype M.86730 (height 12.5 mm, width 9.30 mm) and paratype MNZ, BS 902 (0648), 34°10.5′S, 172°11.4′E, off Three Kings Is., dead, 153 m, 1 February 1981, r.v. *Tangaroa*. Paratypes (14, all from off Three Kings Is.): BS 900 (0646), 33°57.0′S, 171°45.4′E, alive, 98-103 m, 31 January 1981, r.v. *Tangaroa* (3 MNZ); BS 905 (0651), 33°57.4′S, 172°19.4′E, alive, 128-123 m, 1 February 1981, r.v. *Tangaroa* (1 MNZ); BS 894 (0640), 34°00.9′S, 171°44.7′E, alive, 201-216 m, 31 January 1981, r.v. *Tangaroa* (1 MNZ); BS 898 (0644), 34°01.2′S, 171°45.8′E, alive, 221-206 m, 31 January 1981, r.v. *Tangaroa* (4 MNZ); E 846, 34°07.5′S, 171°57.5′E, dead, 417 m, 16 March 1968, m.v. *Viti* (1 NZOI); BS 902 (0648), 34°10.5′S, 172°11.4′E, dead, 153 m, 1 February 1981, r.v. *Tangaroa* (2 MNZ); BS 906 (0652), 34°14.8′S, 172°13.6′E, dead, 173-178 m, 2 February 1981, r.v. *Tangaroa* (1 MNZ).

Other Material Examined: 189 specimens from 21 stations off Three Kings Is., 53-805 m, MNZ, mostly immature.

Distribution (figure 33): Off Three Kings Islands (33°57.0′S-34°22.8′S), 53-805 m, taken alive at 98-221 m on rugged, comminuted bryozoan/shell substratum with sponges, hydroids, gorgonians, corals, etc.

Diet: Unknown.

Remarks: *Calliostoma regale* resembles the sympatric species *C. osbornei* in shape but differs in details of colour and colour pattern and in development of teleoconch sculpture, including appearance of S2 before S3 and slow enlargement of P1 on the first two whorls. Among previously described New Zealand Recent calliostomatids, it is rendered highly distinctive by the presence of fine axial riblets between P3 and P4 on the early teleoconch whorls, which facilitates recognition of even very immature specimens (figure 109). *Calliostoma regale* seems to be closely related to *C. simplex* Schepman, 1908 from the Banda Sea, from which it differs principally in having more markedly convex spire whorls and stronger nodules on the base. Moreover, P1 develops later, and P2 and P3 are relatively larger on the early teleoconch whorls. Although the protoconch and first teleoconch whorl of the holotype of *C. simplex* (ZMA) are eroded, enough remains to show that P1 is present almost immediately after the protoconch and that it is as large as P2 midway through the second whorl. In *C. regale*, P1 commences late on the second or early on the third whorl and does not rival P2 in size until midway through the third or fourth whorl. *Calliostoma simplex* is otherwise similar in the order of appearance of the secondary spirals and in having axial riblets between P3 and P4.

Etymology: Royal (Latin). Alluding to the Three Kings Islands.

Calliostoma (Maurea) aupourianum Marshall, new species
(Figures 42, 50, 112, 133)

Description: Shell up to 8.60 mm high, glossy, of moderate thickness; spire narrowly and rather evenly conical, up to 1.65 × higher than aperture; mean spire angle 58-65°, anomphalous. Colour of extreme tip of protoconch yellowish brown, elsewhere white. Subsequent whorls yellowish or pale yellowish brown, spire irregularly axially mottled in a darker shade, each dark band followed by a narrow white band, base in adults irregularly axially mottled in yet darker shades. Protoconch 370-380 μm

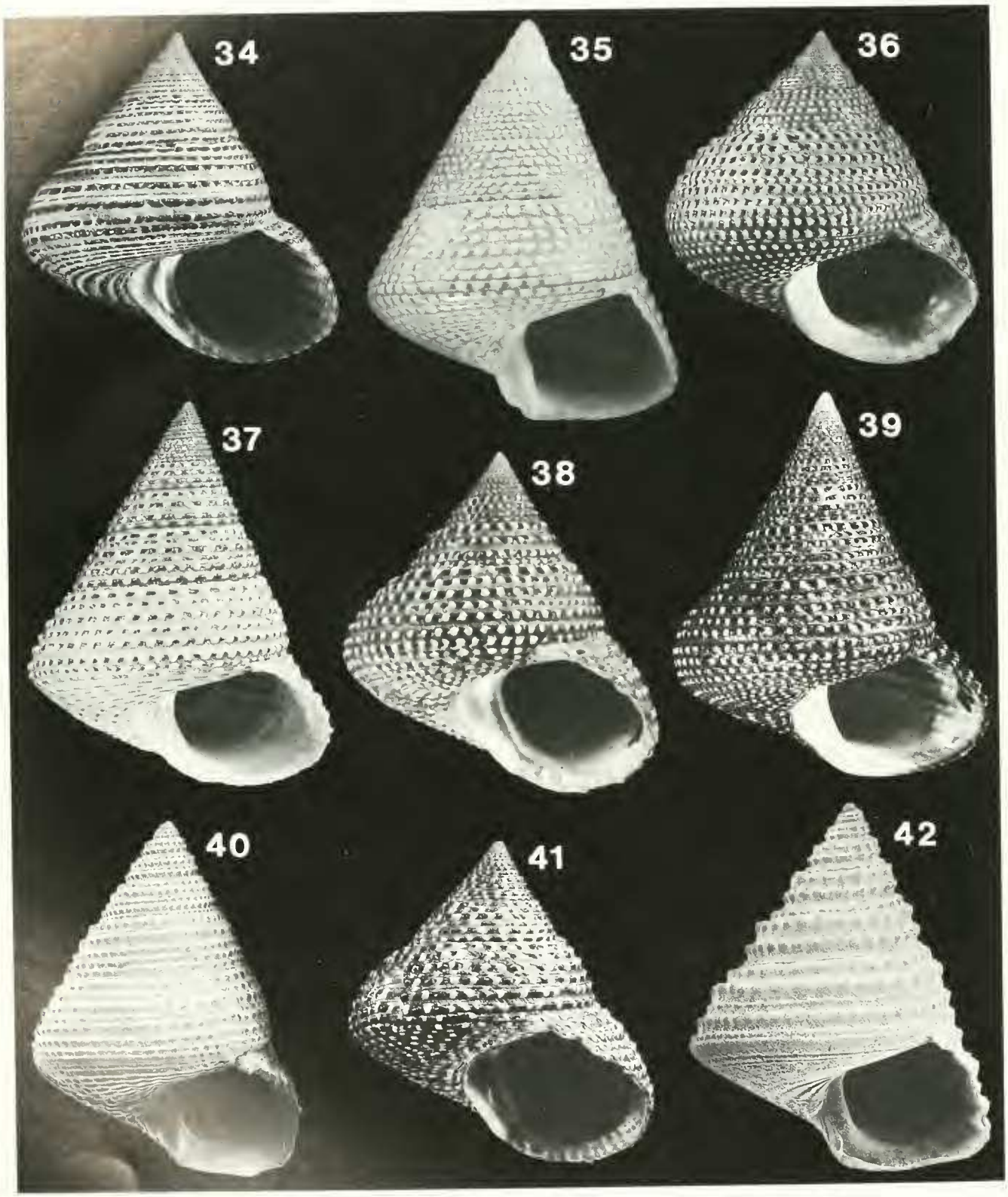


Figure 34. *Calliostoma (Maurea) benthicola* (Dell, 1956). Mernoo Bank, Chatham Rise, 95 m, MNZ M.23626 (30.5 × 29.0 mm). **Figure 35.** *Calliostoma (Maurea) gibbsorum* Marshall, new species. Holotype, off Three Kings Islands, 82 m, MNZ M.35456 (16.8 × 12.5 mm). **Figure 36.** *Calliostoma (Maurea) jamiesoni* Marshall, new species. Holotype, off Three Kings Islands, 15 m, MNZ M.75141(28.5 × 26.0 mm). **Figures 37-39, 41.** *Calliostoma (Maurea) osbornei* Powell, 1926. **37.** North Ahipara Bank, western Northland, 53-56 m, MNZ M 74590 (25.0 × 19.5 mm). **38.** Between Pandora Bank and Cape Maria Van Diemen, 38-43 m, MNZ M 70955 (22.7 × 20.8 mm). **39.** Astrolabe Reef, off Motiti Island, 20-23 m, MNZ M 117841 (32.7 × 26.0 mm). **41.** Seal Rock,

wide, sculptured with network of fine threads that enclose roughly hexagonal spaces, terminal varix strong, rounded. Teleoconch of up to 6.4 whorls. First few whorls rather strongly convex, later whorls weakly convex, early or all whorls distinctly angulated at P2, periphery subangulate at maturity, base more or less flat. First quarter whorl delineated by a fine growth scar, sculptured with 2 rounded axial varices and fine spiral threads. Subsequent whorls encircled by prominent spiral cords with conical nodules, spirals multiplying by intercalation from 3 (P2-P4) to 7 (P1-P4, S1-S3), secondaries enlarging to resemble primaries. P4 smooth throughout, S3 finely nodular or smooth, other spire spirals nodular. On 3rd and 4th whorls, or all whorls other than last adult whorl, a single nodule on P2 is considerably enlarged and white immediately following each dark mottling; interval at about each 3rd nodule on early whorls, intervals variable and up to 7 nodules apart on later whorls. P1 commencing early on or midway through 2nd whorl, gradually enlarging to resemble P3; P2 and P3 commencing immediately after growth scar on 1st whorl. P4 almost or entirely covered by succeeding whorls, becoming fully exposed on penultimate whorl by descent of last adult whorl, smooth throughout. S1 commencing late on 5th or 6th whorl or entirely absent in adults, S2 commencing late on 3rd to midway through 4th whorl, S3 commencing early on 4th or 5th whorl. Up to 3 tertiary spirals may intercalate on last adult whorl. Axial riblets strong on 1st 3 whorls, weakening and becoming obsolete on 4th whorl. Interspace of P3 and P4 on 3rd-5th whorls with numerous fine, close, crisp, secondary axial riblets that become obsolete on succeeding whorl. Basal spirals smooth throughout, numbering 11 or 12. Fine collabral growth lines throughout, stronger on base. Aperture subquadrate, strongly thickened immediately within in adults, especially at base and columella.

Type Data: Holotype M.86731 (height 7.15 mm, width 6.00 mm) and paratype MNZ: BS 395, 34°10′S, 172°12′E, off Three Kings Is., dead, 252 m, 19 February 1974, r.v. *Acheron*. Paratypes (5 MNZ): BS 905 (0651), 33°57.4′S, 172°19.4′E, off Three Kings Is., alive, 128-123 m, 1 February 1981, r.v. *Tangaroa* (1); BS 901 (0647), 34°14.1′S, 172°09.0′E, off Three Kings Is., dead, 192-202 m, 1 February 1981, r.v. *Tangaroa* (1); BS 833 (0578), 37°38.5′S, 178°56.4′E, SE slope of Ranfurly Bank, East Cape, dead, 153-143 m, 22 January 1981, r.v. *Tangaroa* (3).

Other Material Examined: 38 specimens from 13 stations off Three Kings Is., dead, 102-805 m, MNZ, mostly immature; BS 747 (R105), 37°16.7′S, 176°17.5′E, off E side Mayor I., dead, 104-109 m, 22 January 1979, r.v. *Tangaroa* (2 immature).

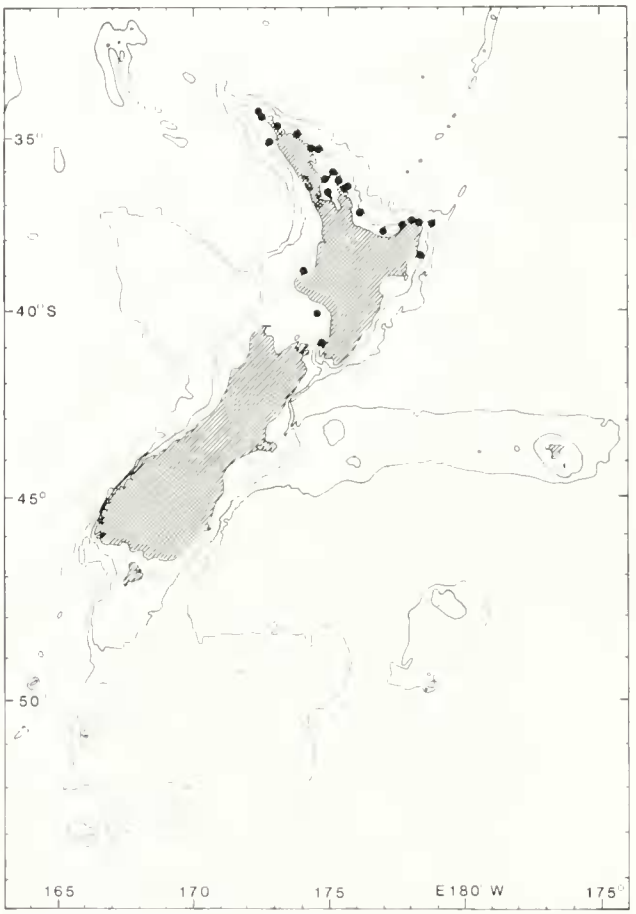


Figure 43. Map of New Zealand region showing distribution of *Calliostoma (Maurea) osbornei*. 200 and 1000 meter contours indicated.

Distribution (figure 50): Off Three Kings Islands, Mayor Island, and East Cape, 102-805 m, taken alive at 123-128 m on rugged comminuted bryozoan/shell substratum with sponges, hydroids, gorgonians, corals, etc.

Diet: Unknown.

Remarks: Compared with the sympatric species *Calliostoma regale*, which it most closely resembles, *C. aupourianum* differs in the later appearance and slower enlargement of the secondary spirals, in having more sharply pointed nodules, in the irregular size of the nodules on P2, and in details of colour pattern as described above.

Etymology: Alluding to the distribution within the boundaries of the former Aupourian marine province.

←

New Plymouth, 12 m, MNZ M.80156 (28.0 × 27.0 mm). **Figure 40.** *Calliostoma (Maurea) regale* Marshall, new species. Holotype, off Three Kings Islands, 153 m, MNZ M.86730 (12.5 × 9.30 mm). **Figure 42.** *Calliostoma (Maurea) aupourianum* Marshall, new species. Holotype, off Three Kings Islands, 252 m, MNZ M.86731 (7.15 × 6.00 mm).

Calliostoma (Maurea) spectabile (A. Adams, 1855) (Figures 44-47, 50, 113, 134)

Zizyphinus spectabilis A. Adams, 1855:37, pl. 27, fig. 7; Reeve, 1863, pl. 1, fig. 5a,b; Hutton, 1873:38, Hutton, 1880:98; Hutton, 1884:360.
Calliostoma spectabilis—Pilsbry, 1889:332, pl. 16, fig. 12.
Calliostoma spectabile—Suter, 1897:280; Suter, 1913:147, pl. 40, fig. 5.
Calliostoma (Mauriella) spectabile—Oliver, 1926:110.
Venustas (Mucrinops) spectabilis—Finlay, 1926:360.
Venustas (Mucrinops) spectabilis—Finlay, 1926:360, 371.
Maurea (Mucrinops) spectabilis—Powell, 1937:64.
Venustas spectabile—Dell, 1950:45, figs. 16-18; Powell, 1955: 55.
Maurea spectabile—Powell, 1957:88.
Calliostoma (Maurea) spectabilis—Cernohorsky, 1977:93, fig. 9.
Maurea spectabilis—Powell, 1979:63, pl. 19, fig. 1.
NOT *Venustas (Mucrinops) spectabilis*—Finlay, 1926:362, pl. 18, fig. 26 (*C. foveauxanum*).

Type Data: Holotype BMNH 1968150 (Cernohorsky, 1977, fig. 9).

Other Material Examined: 55 specimens in 27 lots MNZ, 4 specimens in 2 lots NZOI.

Distribution (figure 50): Off Auckland and Campbell islands, 0-146 m, taken alive at 9-146 m from hard substrata.

Diet: Guts examined contained thecate hydroids (Cnidaria) and much indeterminate organic matter.

Remarks: This species is characterised by a large, heavy, strongly sculptured shell; cyrtoconoid early spire whorls; and convex, rapidly expanding early teleoconch whorls. Late teleoconch whorls range from strongly convex to almost flat, and the spire is broadly to narrowly conical (sa 52-80°, mean 61°, SD 7.59, $n = 29$), the most broadly conical specimens tending to have the most strongly convex whorls. Specimens washed ashore and living as deep as 9 m at the Auckland Islands (figure 45) have the most broadly conical spires (sa 60-80°, mean 70°, SD 5.83, $n = 9$). Auckland Islands specimens (figure 47) from greater depths (37-146 m) and all Campbell Island shells (figure 46) are exclusively narrow-spired (sa 52-60°, mean 56°, SD 2.93, $n = 20$), though some beach shells from the Auckland Islands may be as narrowly conical (figure 44). Most specimens from Campbell Island (figure 46) are more weakly nodular than Auckland Islands specimens, and have slower enlargement of the secondary spirals, though similar forms occur in both populations. Whilst Auckland and Campbell islands populations are probably conspecific, the differences suggest that there may be little genetic exchange between them.

Calliostoma (Maurea) foveauxanum (Dell, 1950) (Figures 48, 50, 114, 135)

Venustas (Mucrinops) spectabilis—Finlay, 1926:362, pl. 18, fig. 26 (not A. Adams, 1855).
Venustas foveauxana Dell, 1950:45, fig. 13-15
Maurea foveauxana—Powell, 1957:88; Powell, 1979:63, pl. 10, fig. 7.
Calliostoma spectabile foveauxanum—Beu, 1976:78.
Maurea blacki—Abbott & Dance, 1982:40 (not Powell, 1950).
NOT *Calliostoma (sensu lato) foveauxanum*—Beu & Maxwell, 1990:404 (*C. blacki* Powell, 1950).

Type Data: Holotype MNZ M.4727, Foveaux Strait, 53 m. Paratype (1 MNZ), Stewart Island.

Other Material Examined: 68 specimens in 8 lots MNZ, 5 specimens in 3 lots NZOI.

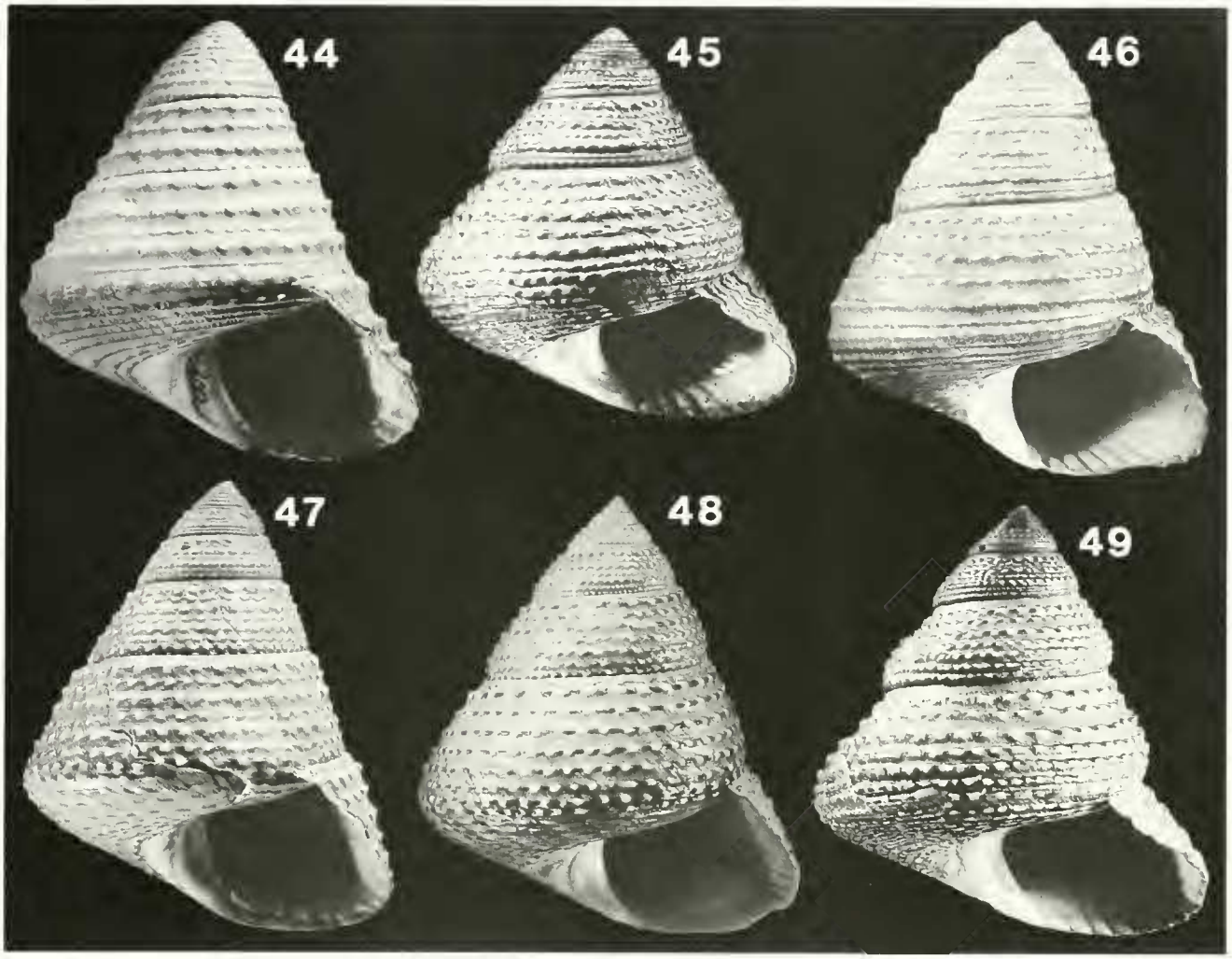
Distribution (figure 50): South-eastern South Island, Stewart Island, and The Snares, 73-549 m, taken alive at 91-220 m from bryozoan/shell substrata.

Diet: Intestinal tracts examined contained mostly thecate hydroids (Cnidaria) with some indeterminate organic matter.

Remarks: From *Calliostoma spectabile*, to which it is most closely related, *C. foveauxanum* differs principally in being more finely sculptured and in that the contour of the early teleoconch is more weakly cyrtoconoid. Although they are allopatric, there is no clinal intergradation within their respective geographic ranges, so it seems likely that they are distinct, closely related species rather than disjunct populations of a single species. Another closely related species from the Antipodes Islands is described below.

Calliostoma (Maurea) eminens Marshall, new species (Figures 49, 50)

Description: Shell up to 51 mm high, higher than broad, spire up to 1.68 × higher than aperture, stout, weakly cyrtoconoid, spire angle 62-66°, suture deep, anomphalous. Colour yellowish brown, spiral cords reddish brown, nodules white, basal spirals alternately spotted reddish brown and white. Parietal and inner lips porcellaneous white. Protoconch unknown (etched). Teleoconch of up to at least 8.5 convex whorls, earliest whorls unknown (eroded—whorl numbers estimated). First 5 whorls rather evenly convex, subsequent whorls flattened adapically, periphery rounded, base weakly convex. After 5th whorl, zone between suture and P1 steepens until almost vertical, channeling suture. Sculpture consisting of strong, rounded spiral cords and weaker axial costae, axials weakening and vanishing on 4th whorl. Spiral cords numbering 6 or (usually) 7 on adult penultimate whorl, comprising P1-P4 plus intercalating secondaries that commence after 1st 4-4.5 whorls, additional tertiaries intercalate on last adult whorl, 7-10 cords on base. First 3 whorls inserted against P4, subsequent whorls descending and inserted between P4 and outermost basal spiral. Spire spirals with rounded nodules, those on P1 strongest, nodules finer and more numerous on abapical half of each whorl, basal spirals undulant. Fine collabral growth lines throughout, some specimens with fine spiral lirae in some spiral interspaces. Aperture ovate. Outer lip thin at rim,



Figures 44-47. *Calliostoma (Maurea) spectabile* (A. Adams, 1855). **44.** Auckland Island, beach, MNZ M.102600 (48.0 × 43.0 mm). **45.** West coast, Auckland Island, 9 m, MNZ M.36711 (51.0 × 49.3 mm). **46.** Boyack Point, Campbell Island, 6 m, MNZ M.117480 (47.0 × 39.4 mm). **47.** North of Auckland Islands, 113m, NZOI D200 (56.0 × 46.0 mm). **Figure 48.** *Calliostoma (Maurea) foveauxanum* (Dell, 1950). Off Otago Peninsula, 130-150 m, MNZ M.117268 (53.5 × 46.8 mm). **Figure 49.** *Calliostoma (Maurea) eminens* Marshall, new species. Holotype, off Archway Island, Antipodes Islands, 13-15 m, MNZ M.84112 (50.8 × 45.0 mm).

thickened within, parietal and inner lips a continuous spreading glaze.

Type Data: Holotype M.84112 (height 50.8 mm, width 45.0 mm, 8 teleoconch whorls) and paratype MNZ, N side of Archway I., Antipodes Is., alive on sloping rock, 13-15 m, 29 November 1978, scuba, D.S. Horning. Paratypes (18): A728, 49°38.4′S, 178°48.7′E, off Antipodes Is., dead, 95 m, 7 November 1962, m.v. *Taranui* (1 NZOI); 49°40′S, 178°53′E, off Antipodes Is., dead, 103 m, USNS *Eltanin* stn 1850 (9 USNM, 3 MNZ); A739, 49°40.19′S, 178°44.3′E, off Antipodes Is., dead, 113 m, 9 November 1962, m.v. *Taranui* (1 NZOI); A 723, 49°42′S, 178°50.3′E, off Antipodes Is., dead, 123 m, 7 November 1962, m.v. *Taranui* (4 NZOI); E side Perpendicular Head, Antipodes Is., under large boulder, alive, 19 m, 27 November 1978, scuba, D.S. Horning (1 MNZ); S side Ringdove Bay, Antipodes Is., on rocks, alive, 18-20 m, 21 November 1978, scuba, D.S. Horning (2 MNZ).

Distribution (figure 50)**:** Off Antipodes Islands, 13-123 m, taken alive at 13-20 m from hard substrata. Probably endemic.

Diet: Guts contain mostly thecate hydroids (Cnidaria) and some indeterminate organic matter.

Remarks: *Calliostoma eminens* differs from its allopatric relatives *C. spectabile* and *C. foveauxanum* in having more strongly convex whorls and in that the suture is set lower on each whorl and is thus correspondingly deeper and the whorls correspondingly more strongly convex. It differs further from *C. spectabile* in being more lightly built and from *C. foveauxanum* in its stronger basal sculpture.

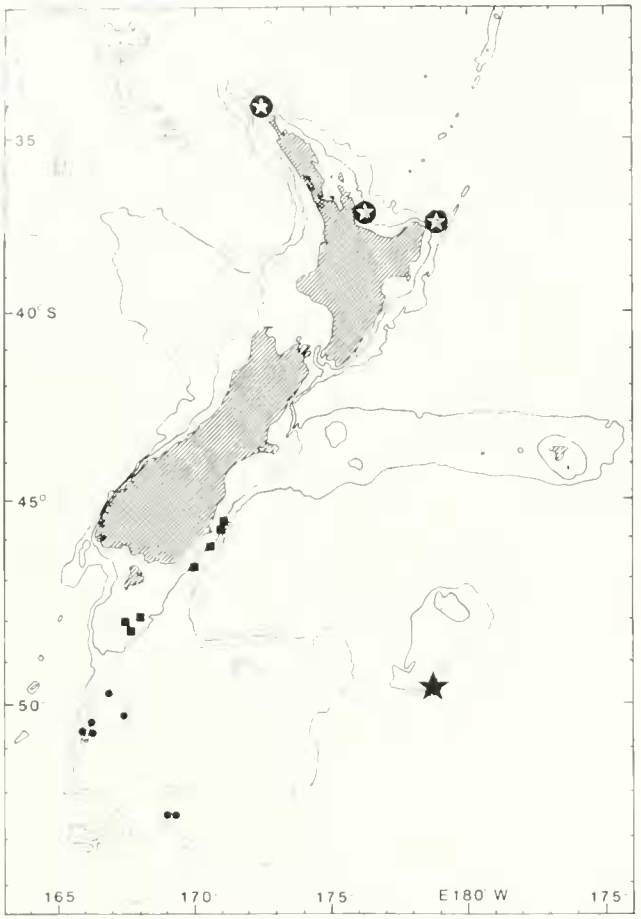


Figure 50. Map of New Zealand region showing distribution of *Calliostoma (Maurea) aupourianum* (hollow star), *C. (M.) spectabile* (circle), *C. (M.) foveauxanum* (square), and *C.(M.) eminens* (solid star). 200 and 1000 meter contours indicated.

Etymology: High (Latin).

Calliostoma (Maurea) blacki (Powell, 1950)
(Figures 51-63, 115, 136)

Venustas blacki Powell, 1950:80, pl. 7, fig. 3, 4.
Venustas couperi Vella, 1954:543, pl. 25, fig. 6, **New synonym**.
Thoristella chathamensis profunda Dell, 1956:44, pl. 6, fig. 57, **New synonym**
Maurea blacki—Powell, 1957:88; Powell, 1979:63, pl. 19, fig. 10, 11
Maurea (Mauriella) couperi—Fleming, 1966:38; Beu, 1978: 724, figs. 11, 13/13
Calliostoma (Maurea) spectabile foveauxana—Beu, 1979:88 (in part not Dell, 1950).
Calliostoma spectabile couperi—Beu, 1981:74, pl. 32, fig. 13.
Calliostoma (sensu lato) couperi—Beu & Maxwell, 1990:404
Calliostoma (sensu lato) foveauxanum—Beu & Maxwell, 1990: 404 (not Dell, 1950).
NOT *Maurea blacki*—Abbott & Dance, 1986:40 (*C. foveauxanum*).
NOT *Maurea blackii* [*sic*]—Horikoshi, 1989, pl. 4, fig. 12 (*C. granti*).

Type Data: *Venustas blacki*: Holotype AIM 71168, off eastern Otago, c.128 m; *Venustas couperi*: Holotype NZGS TM 4995, east side of Makara Stream, north of Te Awaite cutting, Wairarapa (early Nukumaruan, Late Pliocene).

Other Material Examined: 128 Recent specimens in 30 lots MNZ, 34 specimens in 13 lots NZOI.

Distribution (figure 63): Late Pliocene (early Nukumaruan) to Recent, Chatham Rise, South Island east coast from Kaikoura southwards; Stewart, Snares, Auckland, Campbell, and Bounty islands, 73-549 m, taken alive at 95-549 m from bryozoan/shell substrata.

Diet: Gut contents examined comprised thecate hydroids (Cnidaria) and indeterminate organic matter.

Remarks: This species has great variation in shell morphology and is frequently confused with *C. foveauxanum* (Beu, 1976:79; Powell, 1979:497) and *C. simulans* in collections. The spire angle ranges from 60° to 91° (mean 75°, SD 6.64, $n = 59$), and the whorls may be more or less flat-sided throughout with an angulate periphery, or they may become convex with increasing shell size so that the last whorl is evenly rounded. Shell thickness may vary by up to a factor of three, and there is considerable variation in the strength of the spiral cords and nodules. There is complete integration between all extremes in shell morphology, and it is clear that all of the specimens examined represent a single, highly polymorphic species. Specimens from the Chatham Rise (figures 51, 53) and some from off Kaikoura, at the northernmost limit of its range, tend to be the most lightly built, more finely sculptured, and more broadly conical (sa 78-91°, mean 82°, $n = 17$) than the more southern ones. The whorls tend to become markedly convex-sided towards maturity (figure 51), although they may remain weakly convex in some specimens from the Chatham Rise east of the Mernoo Bank (figure 53). Specimens from the Pegasus Canyon off Banks Peninsula (figure 52) and from southward to off Timaru (figures 55, 56) are slightly heavier-shelled than specimens from the north, and most are more narrowly conical (sa 71-79°, mean 73°, $n = 6$) and more strongly nodular, with more weakly convex whorls. In some specimens from off East Otago (sa 71-83°, mean 76°, SD 3.13, $n = 28$) (figure 57), including the holotype, the whorls become as strongly convex as in most specimens from localities to the north, but most of them are as narrowly conical as shells from Pegasus Canyon southward to off Timaru. Specimens from off Stewart Island and The Snares (figure 58) are indistinguishable from most East Otago specimens. Specimens from off the Auckland Islands (figure 62) and Campbell Island are the thickest and most strongly sculptured and are consistently narrowly conical (sa 62-70°, mean 67°, $n = 4$) with almost flat-sided whorls. Specimens from off the Bounty Islands (figure 60) have the most strongly flattened whorls and the narrowest spires (msa 60-63°, mean 61°, $n = 5$) and are thinner and more finely sculp-

tured than shells from off Auckland and Campbell islands. Thus the shell in *C. blacki* tends to become more narrowly conical towards the south and shows a roughly oscillating cline in whorl convexity between Kaikoura and East Otago.

Evidence that spire angle is at least partly a response to sea temperature is suggested by the occurrence of long-dead (probably Pleistocene), narrowly conical, thick, strongly nodular shells in dredge samples containing living specimens with broadly conical, thin, finely nodular shells from the Mernoo Bank (BS 655, 43°07.2'S, 175°22.9'E, 148-150 m, MNZ M.61184, M. 61185) (figure 61) and off the Chatham Islands (NZOI D876, 43°20'S, 176°50'W, 148 m). A long-dead (probably Pleistocene) specimen has been obtained from off Palliser Bay (41°33'S, 174°50'E, c.274 m, MNZ M.11534), which is north of the northernmost known living specimens (NZOI C703, off Kaikoura, 42°42'S, 173°37.8'E, 180-140 m), and resembles living specimens taken from Pegasus Canyon and southward to off Timaru. This specimen occurred with similarly preserved valves of the stenothermic, cool-water pectinid *Chlamys delicatula* (Hutton, 1873) (MNZ M.11521), which is currently unknown living north of Cook Strait (Pantin, 1963). Past northward range expansions of *C. delicatula* have been interpreted as evidence of lowered sea temperature by Fleming (1944, 1951), Boreham and Fleming (*in* Pantin 1957), Beu (1969, 1974, 1977), and Beu *et al.* (1977). Past northward range extensions of *C. blacki* also appear to be associated with low temperatures, and the narrowly conical, flat-sided, strongly sculptured, subrecent northern shells are considered to have lived when sea temperatures were cooler than at present. This explanation could account for the occurrence of old-looking shells from submarine canyons off East Otago, notably the Papanui Canyon (NZGS RM4721), which have flatter-sided whorls than any known Recent specimens from the vicinity. The holotype of the Late Pliocene (Nukumaruan) *Venustas couperi* Vella, 1954 (figure 59) is essentially similar to Recent specimens of *C. blacki* from off Timaru and East Otago, and it is considered to be conspecific. *Thoristella chathamensis profunda* Dell, 1956 is based on juveniles from the vicinity of the type locality. The Late Pliocene (Nukumaruan) specimen from Oaro recorded by Beu (1979) resembles Recent specimens from the vicinity (off Kaikoura). *Calliostoma blacki* may be distinguished from *C. foveauxanum* by the following characteristics: (1) spiral interspaces translucent white or pinkish white instead of yellowish brown; (2) spiral cords reddish brown with white nodules after first 1.5 whorls instead of uniform reddish brown or at least unicoloured (including nodules) on first 4 teleoconch whorls; (3) P4 on first 5 teleoconch whorls almost entirely covered by succeeding whorls and alternately spotted reddish brown and white instead of almost entirely exposed and uniform reddish brown; (4) 5th and 6th teleoconch whorls more strongly convex in *C. foveauxanum*; and (5) *C. blacki* attains smaller shell size than *C. foveauxanum* within the geographic range of the latter (height up to 50 mm as against 62 mm or more). Unlike *C. blacki*, shell morphology in *C. foveauxanum* is extremely stable.

Calliostoma (Maurea) megaloprepes (Tomlin, 1948) (Figures 63, 64)

Maurea (Mucrinops) megaloprepes Tomlin, 1948:225, pl. 2, fig. 1

Venustas megaloprepes—Powell, 1955:55.

Maurea megaloprepes—Powell, 1957:88, Powell, 1979:63, pl. 19:2.

Type Data: Holotype BMNH 1951.6.13.38, BANZARE stn 80, off north-eastern corner of Macquarie Island, 120-80 m.

Other Material Examined: 15 live-taken specimens: 54°24'S, 159°01'E, 79-93 m, 10 February 1965, USNS *Eltanin* stn 1417 (6 USNM, 3 MNZ); C733, 54°25'S, 159°02'E, 104 m, 25 November 1961, m.v. *Viti* (2 NZOI); 54°32'S, 159°02'E, 86-101 m, 10 February 1966, USNS *Eltanin* stn 1418 (1 USNM); D9, 54°52'S, 158°50'E, 113 m, 20 April 1963, m.v. *Viti* (2 NZOI); C730, 54°55'S, 158°47'E, 110 m, 24 November 1961, m.v. *Viti* (1 NZOI).

Distribution (figure 63): Off Macquarie Island, living at 79-113 m on bryozoan/shell substrata. Endemic.

Diet: Gut contents examined comprised mostly foraminiferal sand with fragments of thecate hydroids (Cnidaria) and indeterminate organic matter.

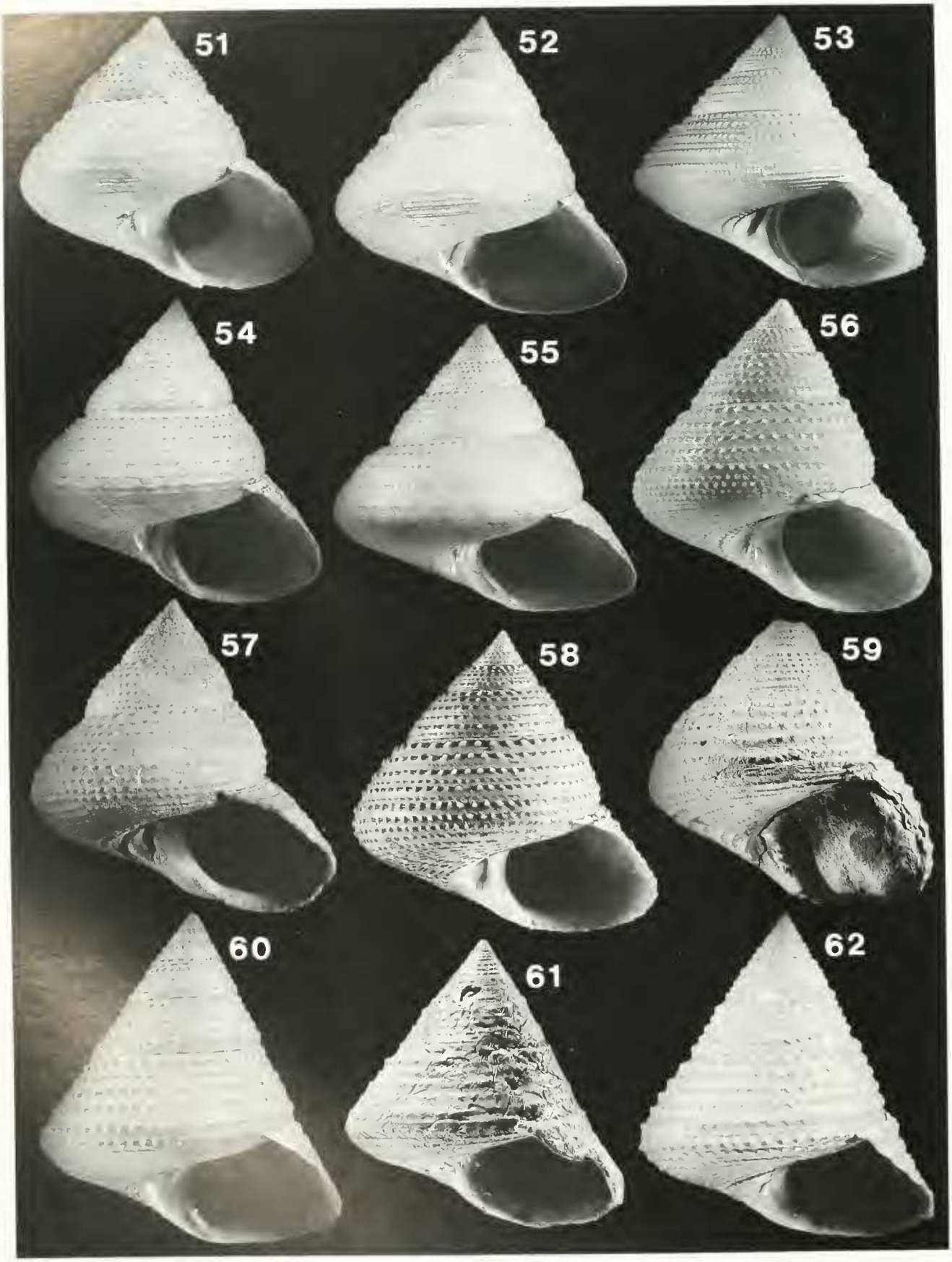
Remarks: This species is rendered highly distinctive by its rich chestnut-brown shell coloration and by the virtual obsolescence of all of the spiral cords other than (rarely including) P1 on the sides and base of the last two adult whorls. *Calliostoma megaloprepes* is otherwise similar to *C. blacki* and the two species are evidently closely related.

Calliostoma (Maurea) simulans Marshall, 1994 (Figures 63, 65-68, 116, 137)

Calliostoma (Maurea) simulans Marshall, 1994. 68, pl.1, figs. 1-3.

Type Data: Holotype MNZ M.87450 (height 30.5 mm, width 29.0 mm, 8.3 teleoconch whorls) and 33 paratypes MNZ: BS 558, 43°30'S 173°31.3'E, head of Pegasus Canyon, NE of Banks Peninsula, alive, 446 m, 27 September 1976, r.v. *Acheron*. Paratypes (158 MNZ): BS 786, 43°25'S, 173°26'E, wall of Pegasus Canyon, alive, 329-183 m, 21 February 1979, r.v. *Acheron* (35); BS 785, 43°25'S, 173°26'E, Pegasus Canyon, alive, 485- 476 m, 21 February 1979, r.v. *Acheron* (59); BS 784, 43°29.5'S, 173°30.5'E, Pegasus Canyon, alive, 402-338 m, 21 February 1979, r.v. *Acheron* (12); BS 783, 43°31'S, 173°30.5'E, Pegasus Canyon, alive, 256-293 m, 21 February 1979, r.v. *Acheron* (52).

Other Material Examined: 3 specimens in 3 lots MNZ, 28 specimens in 13 lots NZOI, 3 specimens in 1 lot USNM.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Distribution (figure 63): Recent, Challenger Plateau, off New Plymouth, Cook Strait to SE of Banks Peninsula, Chatham Rise, and off Bounty and Campbell islands, 183-1006 m, taken alive at 256-410 m from soft substrata with shells.

Diet: Intestinal tracts of all specimens examined contained fragmented chitinous polychaete tubes (Sedentaria, probably Chaetopteridae) and indeterminate organic matter.

Remarks: *Calliostoma simulans* is characterised by a rather large shell with strong spiral cords on the spire and convex, evenly expanding whorls. Shell characters are rather stable throughout the geographic and bathymetric range, though specimens from the west coast (figure 67) and from Cook Strait southward to Banks Peninsula, including the type material (figure 65), are more lightly built and attain smaller size than specimens from elsewhere (figures 66, 68). Occurring throughout most of the range of the highly polymorphic species *C. blacki*, and locally in sympatry, most specimens of *C. simulans* are strongly differentiated from *C. blacki*, but some forms of *C. blacki* from the Chatham Rise and off the southeastern South Island (figures 54, 57) approach *C. simulans* in convexity of the late teleoconch whorls. *Calliostoma simulans* differs from all forms of *C. blacki* in having more strongly convex early teleoconch whorls. It differs further from *C. blacki* from localities other than the eastern Chatham Rise in that S1 becomes as large as P1 or (in most specimens) larger, and the nodules on S1 become correspondingly as large or larger. By contrast, in *C. blacki* from other than the eastern Chatham Rise, S1 only occasionally becomes as large as P1 and the nodules on P1 are consistently larger than those on S1 before the last adult whorl. Although specimens of *C. blacki* from the Chatham Rise east of Veryan Bank (figure 53) have P1 as finely nodular as in *C. simulans*, all pass through a stage on the early teleoconch when P1 is by far the most strongly nodular spiral cord as in other forms of the species. Despite the similarity of some Chatham Rise specimens to *C. blacki*, the two species are strongly differentiated where they occur in strict sympatry, such as off Banks Peninsula (figures 52, 65) and particularly off the Bounty Islands and off the Auckland Islands and Campbell Island (figures 62, 68).

Calliostoma (Maurea) antipodense Marshall, new species
(Figures 63, 69, 117, 138)

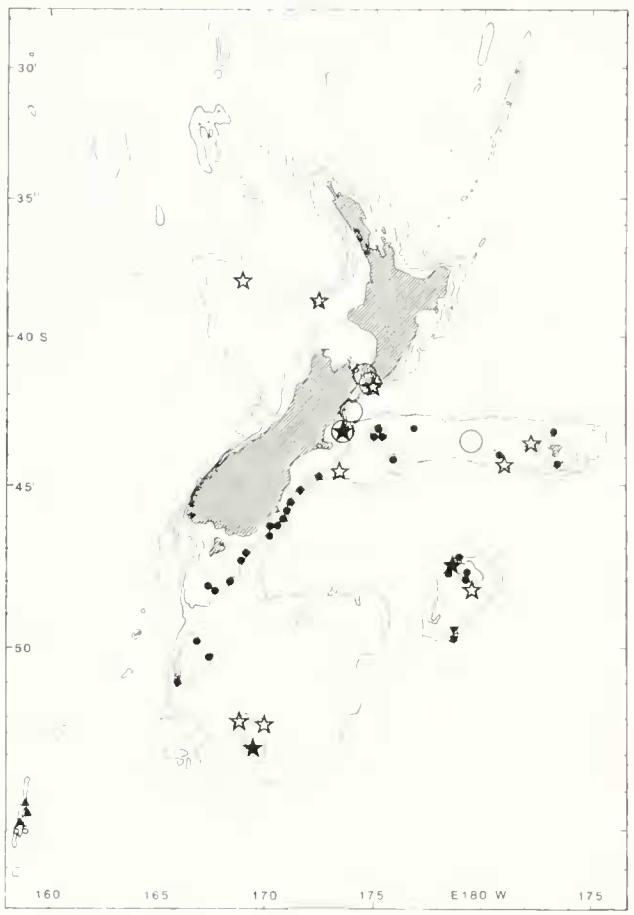

Figure 63. Map of New Zealand region showing distribution of *Calliostoma (Maurea) blacki* (solid circle), *C. (M.) maui* (open circle), *C. (M.) simulans* (star, solid star = sympatric with *C. (M.) blacki*), *C. (M.) antipodense* (inverted triangle), and *C. (M.) megaloprepes* (upright triangle). 200 and 1000 meter contours indicated.

Description: Shell up to 37 mm high, slightly higher than broad, rather thin, anomphalous, glossy; spire up to 1.77 × as high as aperture, rather evenly conical, spire angle 71-74°. Colour orange buff, spiral cords reddish brown between paler nodules. Protoconch 400 μm wide, sculptured with network of fine threads that enclose hexagonal spaces, terminal varix strong. Teleoconch of up to 8.5 strongly convex whorls, suture becoming deeply channeled after 4th whorl, periphery rounded, base

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Figures 51-62. *Calliostoma (Maurea) blacki* (Powell, 1950). **51.** Mernoo Bank, Chatham Rise, 95 m, MNZ M.118378 (37.5 × 40.0 mm). **52.** Pegasus Canyon, off Banks Peninsula, 256-293 m, MNZ M.64651 (41.7 × 40.4 mm). **53.** Off Chatham Islands, 315-279 m, MNZ M.90037 (40.3 × 43.4 mm). **54.** Off Oamaru, c. 90 m, MNZ M.102603 (44.3 × 42.8 mm). **55, 56.** Off Timaru, 293 m, NZOI E424 (55.0 × 55.3 mm, and 51.0 × 49.4 mm). **57.** Continental Shelf off Dunedin, MNZ M.7209 (51.0 × 50.0 mm). **58.** Off The Snares, 154-168 m, MNZ M 92443 (42.3 × 41.0 mm). **59.** Holotype of *Venustas eouperi* Vella, 1954, Late Pliocene-Early Pleistocene (Nukumaruan), Makara Stream, Wairarapa, NZGS TM4995 (34.2 × 35.8 mm). **60.** Off Bounty Islands, 155 m, NZOI 1708 (42.8 × 37.5 mm). **61.** Subrecent (probably Late Pleistocene), Mernoo Bank, Chatham Rise, 148-150 m, MNZ M 61185 (41.0 × 39 0 mm). **62.** Off Auckland Islands, 113 m, NZOI D200 (45.4 × 40.0 mm).

weakly convex. First 0.2 whorls delineated by a growth scar, with 2 axial costae and 4 spiral threads. Subsequent spire whorls sculptured with spiral cords that multiply by intercalation from 4 (P1-P4) to 9 (P1-P4, S1-S3 + 2 suprasutural spirals); summit of P4 partly covered by succeeding whorls on 1st 4 whorls, after which insertion point progressively descends to fully expose P4 and then 2 additional spirals, the lower of which is either partly covered by succeeding whorls or fully exposed; nodules rounded on P1, P2, P3, S1, and S2, other spirals smooth, spiral interspaces considerably wider than each spiral. P1 at first much weaker than P2 and P3, which are strong and similar throughout, gradually enlarging over 1st 5 whorls then weakening and becoming obsolete. Secondary spirals enlarging to resemble adjacent primaries. S1 and S2 commencing on mid 4th to early 5th whorl, S3 commencing mid 4th to mid 5th whorl. Base with 6 spiral cords of similar size, weaker than spire spirals, inner 3 smooth or with rounded nodules, others smooth. Axial costae strong on 1st 3 whorls, weakening and vanishing on 4th whorl. Fine spiral lirae on 1st 3 or 4 whorls, fine collabral growth lines and obscure spiral lines throughout; fine spiral threads in basal interspaces and intercalating in spiral interspaces on spire on last 1 or 2 adult whorls. Aperture ovate, outer lip simple, inner lip thickened, parietal glaze extremely thin and transparent.

Type Data: Holotype MNZ M.80434 (height 31.8 mm, width 29.2 mm, 8.3 teleoconch whorls) and paratype, off Leeward I., Antipodes Is., alive, 18-73 m, 21 November 1972, r.v. *Acheron*. Paratypes (31): *Eltanin* stn 2141, 49°40′S, 178°52′E, off Antipodes Is., alive, 86-95 m (2 MNZ, 4 USNM); *Eltanin* stn 27/1850, 49°40′S, 178°53′E, off Antipodes Is., alive, 103 m, 3 January 1967 (4 MNZ, 20 USNM).

Distribution (figure 63): Off Antipodes Islands, taken alive at 18-103 m (minimum limit uncertain) from hard substrata. Probably endemic.

Diet: The intestinal tract of the specimen examined contained many calcareous octocoral scales (Cnidaria, Primnoidae), a few thecate hydroid fragments, and sand.

Remarks: Compared with *C. simulans*, to which it is most closely related, *C. antipodense* differs in its deeper shell pigmentation, more strongly convex whorls, deeply channeled suture, and obsolescence of P1 after the fifth teleoconch whorl. Interestingly, *C. eminens*, the other Antipodes Islands endemic, also has an exceptionally deep suture.

Calliostoma (Maurea) maui Marshall, new species
(figures 63, 70-72)

Description: Shell up to 44 mm high, broader than high, thin, anomphalous or with a shallow umbilical depression, glossy; spire 1.24-1.59 × higher than aperture, evenly conical, spire angle 73-91°. Protoconch and earliest teleoconch whorls translucent white. Subsequent whorls either pale pink through uniform translucent white outer shell layer or pale buff or pinkish buff with yellowish or reddish brown spiral cords and predominantly white nodules. Protoconch ca. 400 μm wide, surface sculpture worn away in all available specimens. Teleoconch of up to 9 strongly and rather evenly convex whorls, suture well impressed, periphery rounded, base weakly convex. Primary sculpture on spire consisting of spiral cords that multiply by intercalation from 4 (P1-P4) to 7 (P1-P4, S1-S3) or occasionally 6 (S3 absent), up to 3 tertiary spirals occasionally arise on penultimate and last adult whorl, summit of P4 partly covered by succeeding whorls and locally fully exposed. Nodules roundly conical; spiral interspaces considerably broader than each spiral, becoming finely spirally lirate. P1-P4 commencing immediately. P1 at first much weaker than P2 and P3, which are similar throughout, gradually enlarging to resemble them, occasionally weakening and becoming obsolete on last adult whorl. Secondary spirals gradually enlarging to resemble primaries, S1 commencing early to late on 4th whorl, S2 on late 3rd to mid 4th whorl, S3 on mid 4th to early 5th whorl. Base covered with spiral lirae, 2 or 3 nodular spiral cords on innermost part, other basal spiral cords almost or entirely obsolete. Axial costae strong on 1st 3 whorls, obsolete thereafter. Aperture ovate, inner lip thickened, parietal lip very thin, outer lip thin and simple.

Type Data: Holotype MNZ M. 87449 (height 27.3 mm, width 31.3 mm, 7.1 teleoconch whorls); BS 561, 41°24′S, 174°33′E, Cook Strait, alive, 256-274 m, 29 September 1976, r.v. *Acheron*. Paratypes (6) : 41°35′S, 175°00′E, off Palliser Bay, alive, 256-490 m, 19-20 December 1966, USNS *Eltanin* stn 1848 (1 USNM); C 703, 42°42′S, 173°37.8′E, off Kaikoura, alive, 180-140 m, 19 June 1961, m.v. *Viti* (1 NZOI); E 759, 42°45′S, 173°40′E, off Kaikoura, alive, 195-213 m, 31 March 1967, m.v. *Viti* (1 NZOI); BS 783, 43°31′S, 173°30.5′E, Pegasus Canyon, NE of Banks Peninsula, alive, 256-293 m, 21 February 1979, r.v. *Acheron* (1 MNZ); 43°56.4′S, 179°25.1′W, W of Chatham Is., alive, 303-296 m, 15 September 1987, f.v. *Chiyo Maru* 5 (1 MNZ); off North Canterbury, alive, ca 100 m, J. Sutherland (1 MNZ).

Other Material Examined: 10 specimens MNZ: BS 542, 41°08′S, 174°35.5′E, Cook Strait, subfossil, 282-293 m, 12 March 1976, r.v. *Acheron* (5); BS 561, 41°24′S, 174°33′E, Cook Strait, subfossil, 256-274 m, 29 September 1976, r.v. *Acheron* (4); VUZ 99, 41°34.3′S, 174°43.3′E, old shell, 274 m, 29 August 1957.

Distribution (figure 63): Cook Strait, Chatham Rise, and off north-eastern South Island, living at 140-490 m on rugged substrata.

Diet: The intestinal tract of the holotype contained mostly fragments of thecate hydroids (Cnidaria), with some indeterminate organic matter.

Remarks: *Calliostoma maui* closely resembles lightly built forms of *C. simulans* and depressed forms of *C. blacki* from the eastern Chatham Rise in general facies,

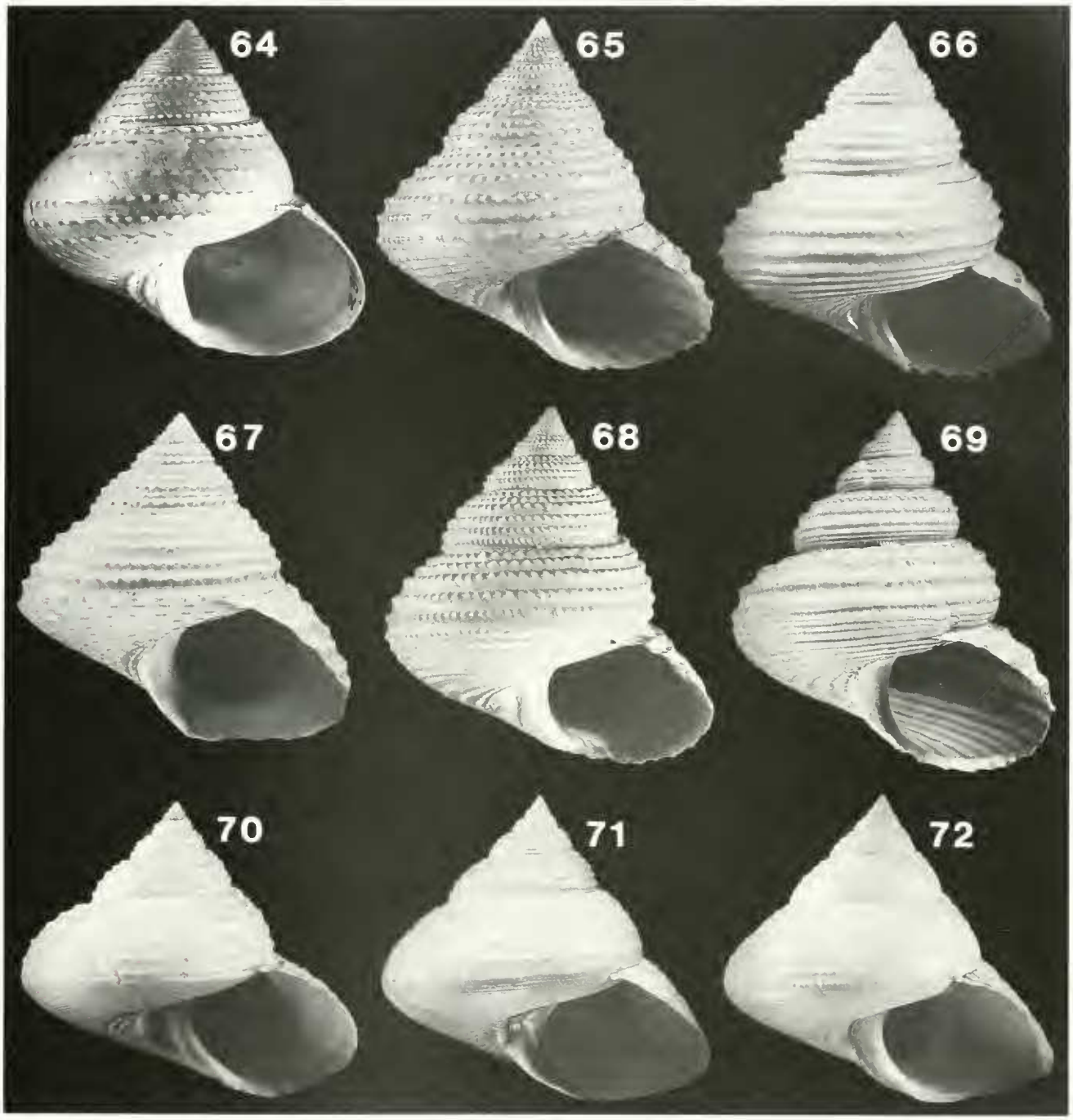


Figure 64. *Calliostoma (Maurea) megaloprepes* (Tomlin, 1948). Off Macquarie Island, 79-93 m, MNZ M.23623 (32.9 × 34.2 mm). **Figures 65-68.** *Calliostoma (Maurea) simulans* Marshall, 1994. **65.** Holotype, Pegasus Canyon, off Banks Peninsula, 446 m, MNZ M.87450 (30.5 × 29.0 mm). **66.** Central Chatham Rise, 410 m, NZOI C259a (51.0 × 48.5 mm). **67.** Challenger Plateau, 337 m, NZOI D242 (27.0 × 27.8 mm). **68.** Off Campbell Island, 188 m, NZOI D35 (52.0 × 48.0 mm). **Figure 69.** *Calliostoma (Maurea) antipodense* Marshall, new species. Holotype, off Leeward Island, Antipodes Islands, 18-73 m, MNZ M.80434 (31.8 × 29.2 mm). **Figures 70-72.** *Calliostoma (Maurea) maui* Marshall, new species. **70.** Holotype, Cook Strait, 256-274 m, MNZ M.87449 (27.3 × 31.3 mm). **71.** Off North Canterbury, ca 100 m, MNZ M 74647 (42.4 × 45.4 mm). **72.** Off Kaikoura, 139 m, MNZ M 102606 (45.0 × 48.7 mm).

all three having similar development of teleoconch sculpture, numerous fine spiral lirae on adult teleoconch whorls, and a tendency toward obsolescence of all but the innermost few spiral cords on the base. *Calliostoma maui* closely resembles *C. simulans* in having all teleoconch whorls markedly convex and in that PI at no stage becomes larger or more heavily nodular than the other primary spire spirals as it does in *C. blacki*. It differs from *C. simulans* in having considerably finer spiral cords on the spire with finer, mostly more sharply pointed nodules, and in being usually more broadly conical (sa 73°-91°, mean 81°, $n = 7$; instead of 66°-81°, mean 72°, $n = 54$). During early stages of the present study I suspected that *C. maui* might be an extreme phenotypic variant of either *C. blacki* or *C. simulans*. Subsequent recognition of a specimen living together with *C. blacki* and *C. simulans* in a single sample from off Banks Peninsula (MNZ M.90065, 64651, 64650), however, suggests that another closely related species is involved. Further evidence is suggested by the occurrence in Cook Strait of populations of *C. maui* that are geographically intermediate between populations of *C. simulans* (figure 63). Living specimens from Cook Strait, including the holotype (figure 72), are distinctive in having a shallow umbilical depression. Broken, worn, rust-stained specimens from the floor of the Cook Strait Canyon (MNZ M.52531, 54912) are evidently Pleistocene fossils that have been reworked by current scour of soft sediment following breaching of a Cook Strait land bridge, probably after the last glaciation (Fleming, 1951, 1963; Pantin, 1957; Marshall, 1978). They have considerably thicker shells than Recent specimens from Cook Strait but are otherwise identical.

Etymology: After Maui, the legendary Maori fisherman.

Calliostoma (Maurea) selectum (Dillwyn, 1817)
(Figures 73-77, 85, 118)

Chemnitz, 1795:168, pl. 196, figs 1896-97.
Trochus selectus Dillwyn, 1817:801, refers to Chemnitz, 1795: 168, pl. 196, figs. 1896–97; Wood, 1825:140, pl. 29, fig. 101a.
Trochus cunninghami Gray, 1834:600, pl. 1, fig. 7; Fischer, 1876:119, pl. 39, fig. 1.
Ziziphinus cunninghami—Gray, 1843:237;
Trochus cuninghami [*sic*]—Philippi, 1855:281, pl. 41, fig. 7.
Zizyphinus cunninghamii—Reeve, 1863:pl. 1, fig. 6
Zizyphinus cunninghami—Hutton, 1873:38; Hutton 1880:98.
Zizyphinus hodgei Hutton, 1875:458, pl. 21. **New synonym**.
Zizyphinus decarinatus—Hutton, 1884:359 (not Perry, 1811).
Zizyphinus ponderosus Hutton, 1885:322. **New synonym**
Calliostoma selectum—Pilsbry, 1889:335, pl. 65, figs. 73, 74 (not pl. 65, fig. 78 = *C. pellucidum*); Suter, 1897:281; Suter, 1913:146, pl. 40, fig. 4.
Calliostoma ponderosa—Hutton, 1893:69, pl. 8, fig. 75; Suter, 1915:2.
Calliostoma hodgei—Hutton, 1893:70; Suter, 1915:2.
Calliostoma carnicolor Preston, 1907:140, pl. 8, figs. 6, 7. **New synonym**
Calliostoma (Calliotropis) pagoda Oliver, 1926:112, pl. 10, fig. 4
Calliostoma (Calliotropis) cunninghamii—Oliver, 1926:112.
Calliostoma (Calliotropis) hodgei—Oliver, 1926:114
Venustas (Venustas) cunninghami—Finlay, 1926:360, 371.
Venustas (Venustas) ponderosa—Finlay, 1926:360, 371.
Venustas (Venustas) hodgei—Finlay, 1926:360, 371.
Venustas cunninghami regifica Finlay, 1927:485, pl. 24, figs. 9, 10, Cernohorsky, 1972:244.
Calliostoma (Calotropis) cunninghamii—Thiele, 1929:49.
Maurea (Maurea) cunninghami cunninghami—Powell, 1937: 64, pl. 13, fig. 1.
Maurea (Maurea) cunninghami pagoda—Powell, 1937:64.
Calliostoma (Calotropis) cuminghami [*sic*]—Wenz, 1938:282.
Maurea (Calotropis) cunninghami cunninghami—Powell, 1946:66, pl. 13, fig. 1.
Maurea (Calotropis) cunninghami pagoda—Powell, 1946:66.
Venustas cunninghami cunninghami—Dell, 1950:53.
Venustas cunninghami pagoda—Dell, 1950:53.
Maurea cunninghami cunninghami—Powell, 1957:88, pl. 13, fig. 1.
Maurea cunninghami pagoda—Powell, 1957:88.
Calliostoma (Maurea) cunninghami—Shikama & Horikoshi, 1963, pl. 8, fig. 15.
Maurea (Calotropis) cunninghami—Fleming, 1966:38.
Maurea hodgei—Fleming, 1966:38.
Maurea ponderosa—Fleming, 1966:38.
Calliostoma (Maurea) selectum—Cernohorsky, 1974:149, fig. 7
Maurea selecta—Powell, 1979:61, pl. 10, fig. 2; Abbott & Dance, 1982:40; Matsukuma, Okutani & Habe, 1991, pl. 17, fig. 10.
Maurea pellucida—Abbott & Dance, 1982:40 (not Valenciennes, 1846).
Calliostoma (sensu lato) selectum—Beu & Maxwell, 1990:404
NOT *Trochus selectus*—Philippi, 1855 (*C. pellucidum*).
NOT *Zizyphinus selectus*—Reeve, 1863; Hutton, 1873, 1880, 1884 (*C. pellucidum*).
NOT *Calliostoma selectum*—Pilsbry, 1889: pl. 65, fig. 78 (*C. pellucidum*).
NOT *Calliostoma (Calotropis) selectum*—Wenz, 1938 (*C. pellucidum*).

Type Data: *Trochus selectus*: Lectotype (here selected) University Zoological Museum, Copenhagen (Cernohorsky, 1974, pl. 149, fig. 7), "coasts of New Zealand"; *Trochus cunninghami*: Holotype BMNH 1987047, ex J.E. Gray collection, no locality data, = New Zealand (probably a Wellington west coast beach); *Zizyphinus hodgei*: Holotype Otago Museum, Dunedin C.54.50, "Wanganui, in blue clay", probably Landguard Bluff (Late Pleistocene, early Haweran); *Zizyphinus ponderosa*: Holotype Canterbury Museum, Christchurch M.2766, "Wanganui", horizon unspecified but probably Butlers Shell Conglomerate (Middle Pleistocene, early Castlecliffian); *Calliostoma carnicolor*: Repository unknown, "Celebes(?)" = New Zealand; *Calliostoma (Calliotropis) pagoda*: Holotype MNZ M.1602, off Cape Campbell, c.37 m; *Venustas cunninghami regifica*: Holotype AIM 70823, off Otago Heads, 55m.

Other Material Examined: *Fossil*—20 Late Pliocene—Early Pleistocene (Nukumaruan) specimens in 8 lots AUG, NZGS; 21 Middle Pleistocene (Castlecliffian) specimens in 18 lots AUG, MNZ, NZGS; *Recent*—273 specimens in 86 lots MNZ.

Distribution (figure 85): Late Pliocene (Nukumaruan) to

Recent; North, South, Stewart and Chatham islands, 0-293 m, living at 27-274 m on sandy or muddy substrata with shell or stones.

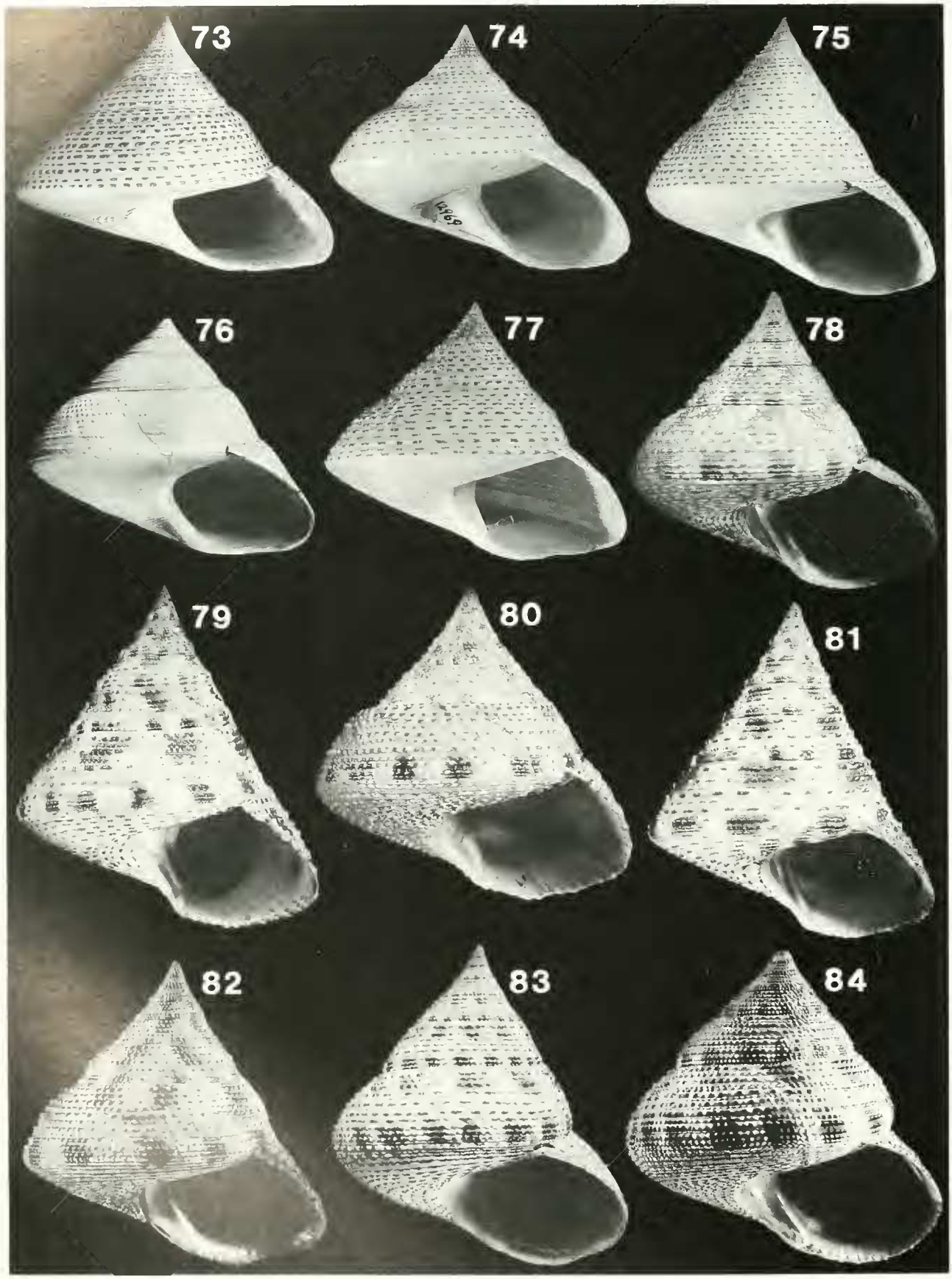
Diet: Gut contents of all specimens examined contained mostly sand with fragments of either agglutinated polychaete tubes or thecate hydroids (Cnidaria), together with indeterminate organic matter. One specimen contained some crustacean fragments.

Remarks: Recent specimens of this well-known species are characterised by large size (diameter up to 70 mm); low, broadly conical spire (sa 73-94°); weakly and evenly convex whorls, angulate or narrowly rounded periphery, weakly to rather strongly convex base, weak axial costae on early teleoconch whorls, similarity of P1-P3 throughout, and the late appearance of the secondary spirals, especially S3. Recent specimens from the South Island east coast from Banks Peninsula southwards tend to have more narrowly conical spires (sa 73-80°, mean 76.8°, SD 1.76, $n = 20$) than specimens from the North Island (sa 74-94°, mean 84.2°, SD 4.49, $n = 40$), but there is complete intergradation between high- and low-spired forms off the northern South Island (sa 77-90°, mean 82°, SD 4.22, $n = 20$) and the southern North Island. Two specimens from off Jackson Bay, Westland (MNZ M.17669) are as broadly conical as material from the northern South Island (sa 81° and 85°). North-south clinal gradation in spire height is independent of depth. There is considerable variation in the strength of nodules on the spiral cords, and many specimens from Cook Strait tend to be particularly weakly nodular (figure 74). Specimens from the Chatham Islands (figure 77) are indistinguishable from mainland material (sa 76-81°, mean 79°, SD 1.87, $n = 5$).

The fragmentary holotype of *Zizyphinus hodgei* resembles specimens from Landguard Bluff (early Haweran, Middle Pleistocene) in shell morphology and preservation, suggesting that it may have come from that horizon. Moreover, it is indistinguishable from Recent specimens from off the east coast of the South Island.

The holotype of *Zizyphinus ponderosa* is a heavily abraded adult shell from an unspecified horizon in the Wanganui sequence. The shell morphology and state of preservation closely match specimens from the Butlers Shell Conglomerate (early Castlecliffian, Early Pleistocene) (figure 76), suggesting that it originated from this horizon. All but one of these specimens (see below) and another from the Nukumaru Brown Sand (GS4115, NZGS; Nukumaruan, Late Pliocene) differ from all specimens from later horizons in having distinctly cyrtoconoid instead of shallowly coeloconoid spires. They also have considerably thicker shells than most Recent specimens, as do most adult Middle Pleistocene specimens from the overlying Pinnacle Sand (GS4022, NZGS) and Shakespeare Cliff Sand formations (AUG 989), although the few Recent specimens known from Stewart Island (MNZ) are as heavily built. However, Early Pleistocene specimens from the Lower Kai Iwi Siltstone (AUG 1028, 1034), which underlies the Pinnacle Sand, are as thin as the most lightly built Recent specimens. Specimens from the Shakespeare Cliff Sand and earlier formations (notably GS4022, NZGS) commonly show much later appearance of some or all of the secondary spirals (especially S3) than any known Recent specimens, often as late as the last or second- to-last adult whorl. Fossils from these early horizons are unlike Recent shells in that the spiral cords frequently become smooth and sometimes very weak after an initial nodular stage, becoming stronger and nodular again on the last or second-to-last whorl or remaining weak and smooth throughout. A single specimen (GS10964, NZGS) collected by A.G. Beu from the Butlers Shell Conglomerate (Early Pleistocene) differs from others from this horizon in being considerably thinner and having a more broadly conical spire that is distinctly coeloconoid rather than cyrtoconoid in outline. As in some other specimens from this horizon, the shell is entirely devoid of nodules on the remaining three whorls, and the spiral cords are almost obsolete on the last adult whorl. It is thus similar to some Middle Pleistocene shells from the Kupe Formation (GS4041, 4121, NZGS) and the thin, weakly sculptured specimens from the Lower Kai Iwi Siltstone (AU1028, 1034, AUG). It is possible that the more lightly built form lived *in situ* in a low-energy environment, whereas the heavier shells may have washed in from a shallower, high-energy environment or were perhaps reworked from a slightly older horizon (presumably late Nukumaruan, Early Pleistocene). This contention is supported by the fact that the heavier shells are all worn to some extent and many are bored, whereas the lightly built (fragile) form was in fresh condition. As discussed by Fleming (1953:175, 176), many shells from the Butlers Shell Conglomerate have undoubtedly been transported, whereas others are clearly reworked from older beds. All of the fossils otherwise resemble Recent specimens in early teleoconch morphology. There is intergradation between specimens with early- and late-developing secondary spirals and between specimens in which the spiral cords are weak or strong and nodular or smooth, both within and between samples from the Shakespeare Cliff Sand and older formations. Accordingly, *Z. ponderosa* and *C. selectum* are interpreted as forms of a single polymorphic species. Great intraspecific variation during the Pleistocene was probably at least partly a response to oscillating glacial-interglacial temperatures and sea levels, with associated variations in sediment type and habitat stability. Interpretation of the fossils is potentially complicated by the likelihood of reworking from older horizons during interglacial marine transgressions.

Calliostoma carnicolor Preston, 1907 was based on a specimen reputedly from the Celebes, though from the description and illustration (Preston, 1907, p.140, pl.8, figs. 6, 7), it appears to be a perfectly typical, northern specimen of *C. selectum*. Nothing similar has been recorded subsequently from the Celebes (or from elsewhere for that matter), and it almost certainly represents a mislocalised specimen of *C. selectum*. The original specimen could not be traced despite extensive enquiries.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Calliostoma (Maurea) pellucidum (Valenciennes, 1846) (Figures 78-84, 86, 119)

Trochus pellucidus Valenciennes, 1846:pl. 4, fig. 2; Fischer, 1875:70, pl. 15, fig. 2.
Trochus torquatus Anton *in* Philippi, 1848.126; Philippi, 1855: 261, pl. 38, fig. 13 (not H C. Lea, 1846).
Trochus punctulatus—Kiener, 1847:pl. 15, fig. 2 (not Martyn, 1784).
Trochus selectus—Philippi, 1855:261, pl 1, figs. 6, 7, pl. 38, fig. 12 (not Dillwyn, 1817).
Zizyphinus selectus—Reeve, 1863:pl. 1, fig. 1; Hutton, 1873: 38; Hutton, 1880:98; Hutton, 1884:359 (not Dillwyn, 1817).
Zizyphinus granatus—Reeve, 1863:pl. 1, fig. 2 (not Gmelin, 1791).
Calliostoma selectum—Pilsbry, 1889:pl. 65, fig. 78 only (not Dillwyn, 1817).
Calliostoma pellucidum—Suter, 1897:281; Suter, 1913:145, pl. 40, fig. 3.
Calliostoma undulatum Finlay, 1923:104, pl. 10, figs. 5a, b. **New synonym**
Calliostoma (Calliotropis) pellucidum pellucidum—Oliver, 1926:111.
Calliostoma (Calliotropis) pellucidum spiratum Oliver, 1926: 111. **New synonym**.
Calliostoma (Calliotropis) undulatum—Oliver, 1926:111.
Venustas (Venustas) pellucida—Finlay, 1926:360, 371.
Venustas (Venustas) undulata—Finlay, 1926:360, 371.
Maurea (Maurea) pellucida pellucida—Powell, 1937:64, pl. 13, fig. 2.
Maurea (Maurea) pellucida spirata—Powell, 1937:64.
Calliostoma (Calotropis) selectum—Wenz, 1938, fig. 603 (not Dillwyn, 1817).
Venustas pellucida pellucida—Dell, 1950.49, figs. 7, 8, 12.
Venustas pellucida spirata—Dell, 1950:50, fig. 3.
Maurea pellucida pellucida—Powell, 1957:88, pl. 13, fig. 2; Powell, 1979:61, pl. 19, fig. 4
Maurea pellucida spirata—Powell, 1957:88; Powell, 1979.61, pl. 19, fig. 6.
Maurea (Calotropis) pellucida—Fleming, 1966:38.
Maurea (Calotropis) undulata—Fleming, 1966:38.
Calliostoma (sensu lato) pellucidum—Beu & Maxwell, 1990: 404.
Calliostoma (sensu lato) undulatum—Beu & Maxwell, 1990: 404.
NOT *Maurea pellucida*—Abbott & Dance, 1982:40 (*C. selectum* Dillwyn, 1817).

Type Data: *Trochus pellucidus*: Lectotype (here selected) and 6 paralectotypes MNHN; *Trochus torquatus*: Repository of type material unknown, "locality unknown". *Calliostoma undulatum*: Holotype NZGS TM 5001, Castlecliff, Wanganui, formation unknown (probably mid-late Castlecliffian or early Haweran, Mid-Late Pleistocene); *Calliostoma pellucidum spiratum* : Holotype MNZ M.11865, Spirits Bay, beach drift.

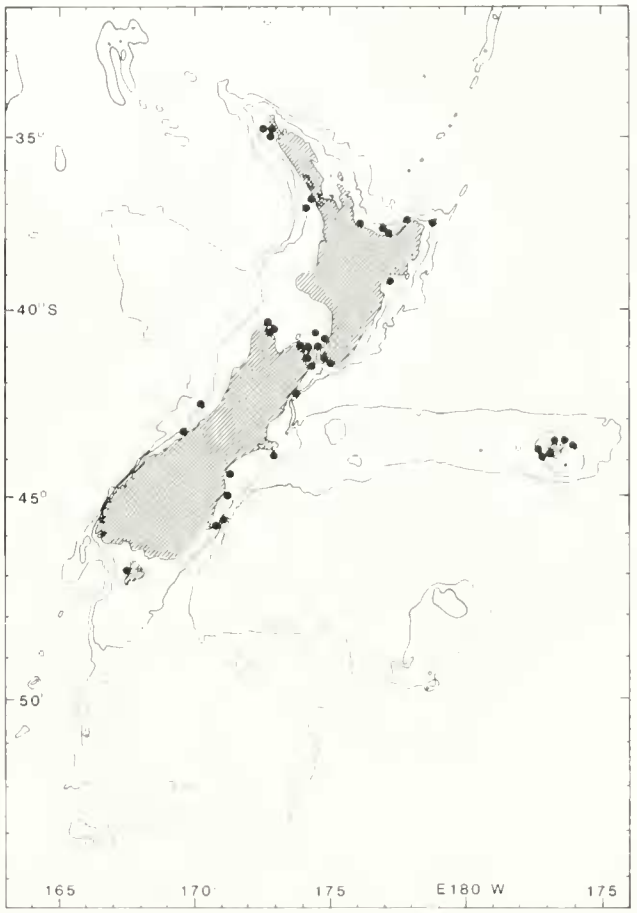

Figure 85. Map of New Zealand region showing distribution of *Calliostoma (Maurea) selectum*. 200 and 1000 meter contours indicated

Other Material Examined: 6 Pleistocene specimens (from unspecified horizons in the Wanganui coastal sequence) in 5 lots MNZ, NZGS, and 235 Recent specimens in 94 lots MNZ.

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Figures 73-77. *Calliostoma (Maurea) selectum* (Dillwyn, 1817). **73.** Off Ahipara, 90 m, MNZ M.72032 (40.0 × 47.8 mm). **74.** Off Palliser Bay, 274 m, MNZ M.12969 (42.7 × 51.0 mm). **75.** Off Timaru, 110-128 m, MNZ M.7162 (47.0 × 50.0 mm). **76.** Early Pleistocene (Castlecliffian), Butler's Shell Conglomerate, Wanganui, NZGS (38.5 × 46.0 mm). **77.** Off Chatham Islands, 248-236 m, MNZ M.90061 (44.7 × 50.2 mm). **Figures 78-84.** *Calliostoma (Maurea) pellucidum* (Valenciennes, 1846). **78.** Takapuna, Auckland, low tide, MNZ M.83646 (38.0 × 38.0 mm). **79.** Paua, Parengarenga Harbour, low tide, MNZ M.80536 (37.7 × 34.0 mm). **80.** Between Pandora Bank and Cape Maria Van Diemen, 33 m, MNZ M.74676 (35.3 × 34.5 mm). **81.** Off Rarawa Beach, Northland, 40 m, MNZ M.86657 (35.0 × 29.5 mm). **82.** Reotahi, Whangarei Heads, low tide, MNZ M.83643 (39.5 × 38.0 mm). **83.** Akaroa Harbour entrance, 20 m, MNZ M.75153 (43.1 × 39.9 mm). **84.** Foveaux Strait oyster beds, 31 m, MNZ M.21719 (48.0 × 47.8 mm).

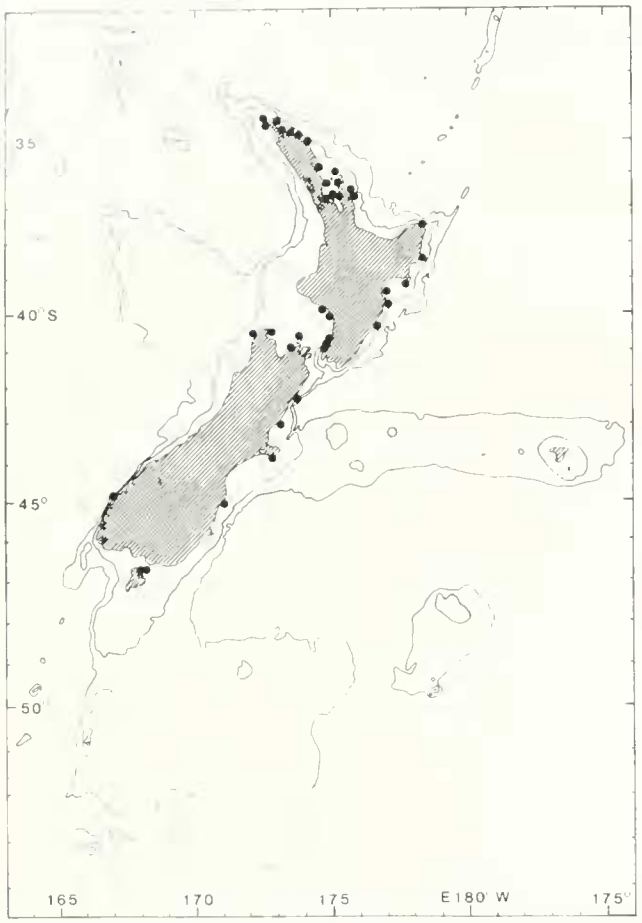


Figure 86. Map of New Zealand region showing distribution of *Calliostoma (Maurea) pellucidum*. 200 and 1000 meter contours indicated.

Distribution (figure 86): Middle Pleistocene to Recent, North, South and Stewart islands, living at 0-187 m on hard substrata.

Diet: Intestinal tracts of specimens examined contained thecate hydroids (Cnidaria) together with some indeterminate organic matter.

Remarks: *Calliostoma pellucidum* has long been confused with the superficially similar species *C. waikanae*, with which it is locally sympatric throughout its range. Highly distinctive characters of *C. pellucidum* include reddish brown subsutural and peripheral maculations, strong teleoconch sculpture, consistent appearance of S3 before S1 and S2, and strong P3 on early teleoconch whorls. The spire is shallowly coeloconoid and 1-1.5 times higher than the aperture, and the spire angle ranges from 56° to 86°. The most narrowly conical specimens occur off eastern Northland north of Whangaroa (sa 57-69°, mean 64°, SD 3.35, $n = 22$), especially in Parengarenga Harbour (figures 79, 81). In specimens from the northwestern extremity of Northland (figure 80), however, including the holotype of *C. pellucidum spiratum* Oliver, 1926, the mean spire angle is rather constantly about 75°, and these broadly conical shells are closely similar to material from south of Whangaroa (sa 68-81°, mean 75°, SD 3.45, $n = 43$) (figures 78, 82-84). The periphery tends to be broadly rounded in southern specimens (figures 83, 84) and more sharply angulate in northern specimens (figures 79, 81), but there is complete intergradation from north to south. The Pleistocene type material of *C. undulatum* Finlay, 1923 is indistinguishable from Recent specimens of *C. pellucidum*.

Calliostoma (Maurea) waikanae Oliver, 1926
(Figures 87-95, 99, 120, 139)

Calliostoma (Calliotropis) waikanae Oliver, 1926:11, pl. 10, fig. 3.
Maurea (Maurea) waikanae—Powell, 1937:64.
Maurea (Calotropis) waikanae—Powell, 1946:66.
Maurea pellucida morioria Powell, 1946:140, pl. 11, fig. 3; Powell, 1979:61, pl. 19,fig. 5. **New synonym**
Venustas pellucida waikanae—Dell, 1950:50, figs. 4,5,9,11.
Venustas pellucida forsteriana Dell, 1950:51, figs. 1,2,10. **New synonym**.
Venustas pellucida morioria—Dell, 1950:53.
Venustas pellucida haurakiensis Dell, 1950:53, fig. 6. **New synonym**.
Maurea pellucida forsteriana—Powell, 1957:88; Powell, 1979:61, pl. 10, fig. 3.
Maurea pellucida haurakiensis—Powell, 1957:88; Powell, 1979:61.
Maurea pellucida morioria—Powell, 1957:88; Powell, 1979:61, pl. 19, fig. 5.
Maurea waikanae—Powell, 1957:88; Powell, 1979:62, pl. 19, fig. 7.

Type Data: *Calliostoma (Calliotropis) waikanae*: Holotype MNZ M.1603, Waikanae Beach; *Maurea pellucida morioria*: Holotype AIM 71037, Owenga Beach, Chatham Islands; *Venustas pellucida forsteriana*: Holotype MNZ M.2120, Preservation Inlet, Stewart Island. *Venustas pellucida haurakiensis*: Holotype NZGS TM 456, Hauraki Gulf, 46 m.

Other Material Examined: *Fossil*—AU1023, Kaikokopu Shell Grit, coastal section, Wanganui (early Castlecliffian, Middle Pleistocene) (1 AUG); GS4045, 4047, 4049, Kupe Formation, coastal section, Wanganui (late Castlecliffian, Middle Pleistocene) (3 NZGS); GS4187, Shakespeare Cliff Siltstone, coastal section, Wanganui (late Castlecliffian) (2 NZGS). *Recent*—470 specimens in 148 lots MNZ.

Distribution (figure 99): Middle Pleistocene (early Castlecliffian) and possibly Middle Pliocene (Waipipian). Recent off North, South, Stewart, Snares and Chatham islands, and Mernoo Bank, 0-549 m, taken alive at 18-549 m on bryozoan/shell substrata.

Diet: Intestinal tracts of specimens examined contained fragments of thecate hydroids (Cnidaria) together with indeterminate organic matter.

Remarks: *Calliostoma waikanae* occurs throughout the geographic range of *C. pellucidum*, and the two species

have been thoroughly confused taxonomically because of their variability and superficial similarity. *Calliostoma waikanae* was treated as a subspecies of *C. pellucidum* by Dell (1950), whereas forms of *C. waikanae* have been consistently treated as "subspecies" of *C. pellucidum*, namely *Maurea pellucida morioria* Powell, *Venustas pellucida forsteriana* Dell, and *V. pellucida haurakiensis* Dell, all of which are here interpreted as local populations of *C. waikanae*. Although they are similar in shape, size, colour, and colour pattern, *C. waikanae* is easily distinguishable from *C. pellucidum* by the constant appearance of S1 and S2 well before S3 instead of vice versa (figures 119, 120). *C. waikanae* differs further in having finer pustules on the side of the foot and tends to have a more lightly pigmented shell with finer, more finely beaded spiral cords, and the summit of P4 is usually partly or entirely exposed on the spire instead of being almost entirely covered by succeeding whorls. In other words the suture is bordered by P4 in *C. waikanae* and by S3 in *C. pellucidum*. S3 is seldom nodular in *C. waikanae*, but constantly becomes strongly nodular in *C. pellucidum* from an early stage of growth.

Most specimens from off the Three Kings Islands and North Cape (figure 88), the north-western North Island southward to off Kawhia (figure 89), and the north-eastern North Island as far south as East Cape (figure 87) have narrower and correspondingly higher spires than specimens from further south (sa 68-76°, mean 72°, n = 27, as against 73-92°, mean 82°, n = 76)(figures 90-95). They differ further in that P3 frequently remains considerably stronger than P1 and P2 onto later whorls, often until the second to last adult whorl, and typically surmounts a prominent, narrow suprasutural bulge together with S3 and P4. Such specimens intergrade completely with specimens in which the primaries become similar through progressive enlargement of P1 and P2 and weakening of P3 at an earlier stage of growth and in which the suprasutural bulge is correspondingly weak or absent. Weakness or absence of a suprasutural bulge is a characteristic of type and topotypic material of *V. p. haurakiensis* and most material from southern localities, though some specimens from Fiordland (figure 94) have a well-developed and persistent peripheral bulge. Specimens from north of Cape Reinga attain larger size (diameter up to 52.5 mm) and are more darkly and extensively pigmented than specimens from elsewhere off the northern North Island but are otherwise identical.

Calliostoma waikanae is exceptionally variable in the area off the west coast of the southern North Island and in Cook Strait. In many specimens from this area, including the holotype of *C. waikanae*, the spiral cords and nodules weaken with increasing shell size, and the nodules may become almost obsolete (figure 91). There is, however, complete gradation between weakly and strongly sculptured forms both within and between populations. Moreover, these specimens show exceptionally wide variation in the development of S3, which may fuse with P4, become as large as P3, remain weak throughout, or entirely fail to appear. Again there is complete mosaic intergradation between the extremes. Pronounced variation in shell morphology in this area is probably at least partly the result of repeated divergence and remixing of populations isolated to the east and west of Cook Strait land bridges that formed during Pleistocene glaciations (Fleming, 1962). This explanation probably also accounts for extreme local variation in direct developers such as buccinids of the genera *Penion* Fischer and *Cominella* Gray.

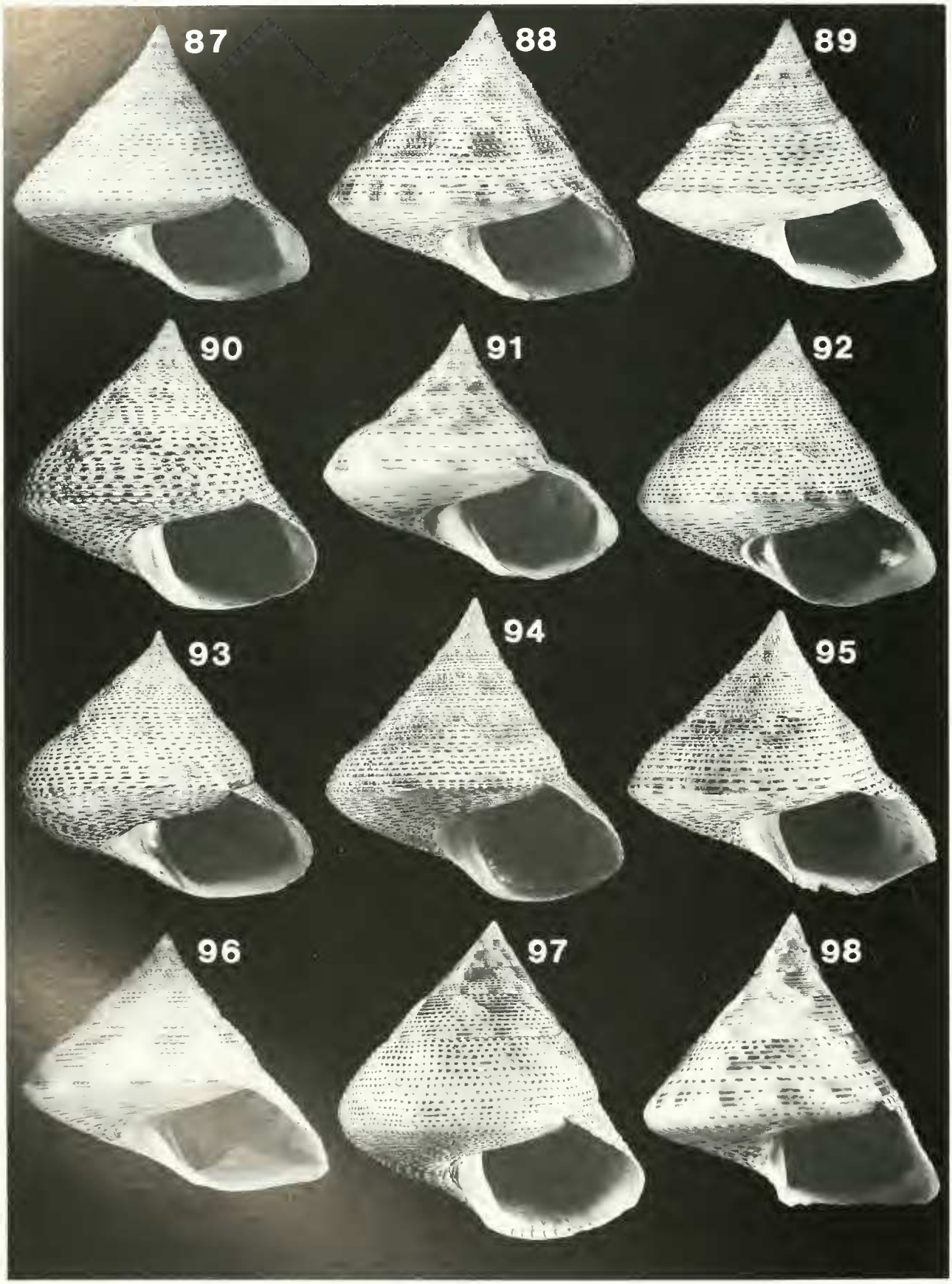
The only significant differences that I am able to detect between specimens from the Cook Strait area and the southern South Island (*forsteriana*) is the more general tendency for the southern form to have a rounded periphery at maturity and a slightly narrower spire angle (73-86°, mean 79°, n = 23 as against 75-92°, mean 82°, n = 53). Again, however, there is complete intergradation both within samples and clinally between the northern and southern forms.

Specimens from the Chatham Islands (*morioria*) (figure 95) are indistinguishable from mainland specimens.

Existing collections suggest that *C. waikanae* has a rather patchy distribution (figure 99) and the differences between specimens from off north-eastern North Island/Kawhia and the Wanganui/Cook Strait area are certainly greater than between specimens from Cook Strait/Kaikoura area and East Otago, suggesting that the northern population may be more strongly isolated than the other mainland populations are from each other. In view of the tendency for this and other New Zealand calliostomatids to form morphologically discrete local populations and to show pronounced clinal geographic and bathymetric variation, it seems clear that all of the nominate forms should be interpreted as local populations of a single polymorphic species.

Middle Pleistocene specimens from the Kaikokopu Shell Grit (AU1023, AUG) and the Kupe Formation, Wanganui (GS4045, 4047, 4049, NZGS), differ from Recent specimens in being thicker at maturity and in the early appearance and more rapid enlargement of the spiral cord between the suture and P1, which develops to resemble P1. The two subadult specimens from the Shakespeare Cliff Siltstone (GS4187, NZGS) are very lightly built and have sculpture that becomes obsolete on the sixth whorl and gradually reappears on the eighth whorl. All of these fossils are indistinguishable from Recent specimens in early teleoconch morphology, and they are interpreted as *C. waikanae* that is both undergoing genetic drift through time and varying in response to changing sea temperature and bathymetry. A single fragmentary specimen from below the Te Aute Limestone, 2.5km south-east of Takapau, Takapau Survey District, Hawke Bay (GS2320, NZGS)—age either Nukumaruan or (more likely) Waipipian (Middle Pliocene) (A.G. Beu, pers. comm.) — is even more similar to Recent *C. waikanae* than the Pleistocene material, but better material is required to ascertain its status.

Calliostoma (Maurea) turaerarum (Powell, 1964)
(Figures 96, 100, 121)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Maurea turnerarum Powell, 1964:11, pl. 3, fig. 1-3; Powell, 1979:62, pl. 19, fig. 9; Horikoshi, 1989:pl. 4, figs. 8,9

Type Data: Holotype AIM 71239, off Mayor Island, Bay of Plenty, 366 m.

Other Material Examined: 37 specimens in 19 lots MNZ.

Distribution (figure 100): Three Kings Islands, off Ninety Mile Beach, and north-eastern North Island as far south as Cape Runaway, 186-805 m, taken alive at 312-529 m on muddy substrata with shells.

Diet: The intestinal tracts of specimens examined contained numerous fragments of thecate hydroids (Cnidaria) together with some indeterminate organic matter.

Remarks: *Calliostoma turnerarum* resembles *C. waikanae* in gross facies, and the two species are undoubtedly closely related. *Calliostoma turnerarum* differs in having a more lightly built shell with finer sculpture on adult whorls and in having pale, wavy axial bands, within which the strongest spiral cords are streaked deep reddish or yellowish brown. Compared with specimens of *C. waikanae* from within its geographic range, *C. turnerarum* is more broadly conical, the spire angle ranging from 83° to 95° (mean 87°, $n = 5$) instead of 68° to 75° (mean 72°, $n = 27$). Although the early teleoconch sculpture is similar in both species, P3 remains similar to P2 in *C. turnerarum*, whereas P3 becomes markedly stronger and more strongly nodular in *C. waikanae*.

Calliostoma (Maurea) penniketi Marshall, new species (Figures 97, 98, 100, 123, 140)

Description: Shell up to 57 mm high, about as high as broad at maturity, spire 1.19-1.78 × as high as aperture, spire outline evenly conical or shallowly cocloconoid, last whorl slightly contracting at maturity, spire angle 65-78°, rather thin but strong, anomphalous throughout. Protoconch and 1st teleoconch whorl white. Ground colour on subsequent whorls pale yellowish brown or buff white, rich yellowish brown on last adult whorl of a few specimens. Spiral cords spotted and spire whorls typically maculated with yellowish or reddish brown, maculations absent from a few specimens. Spiral cords becoming spotted after 2nd-4th whorl, typically on each alternate spiral on early whorls and on each spiral on later whorls, nodules predominantly white on last 2 adult whorls, most deeply pigmented on maculations. Maculations irregular, subquadrate, occupying rather discrete subsutural and suprasutural zones, becoming obsolete on last whorl. Subsutural maculations typically more darkly pigmented than suprasutural ones, almost entirely traversing early whorls, narrowing to occupy adapical half of later whorls, numbering 7-9 on adult penultimate whorl. Suprasutural maculations small, occupying narrow band throughout, numbering 13 or 14 on adult penultimate whorl. Inner lip white, aperture nacreous. Protoconch 370 μm wide,

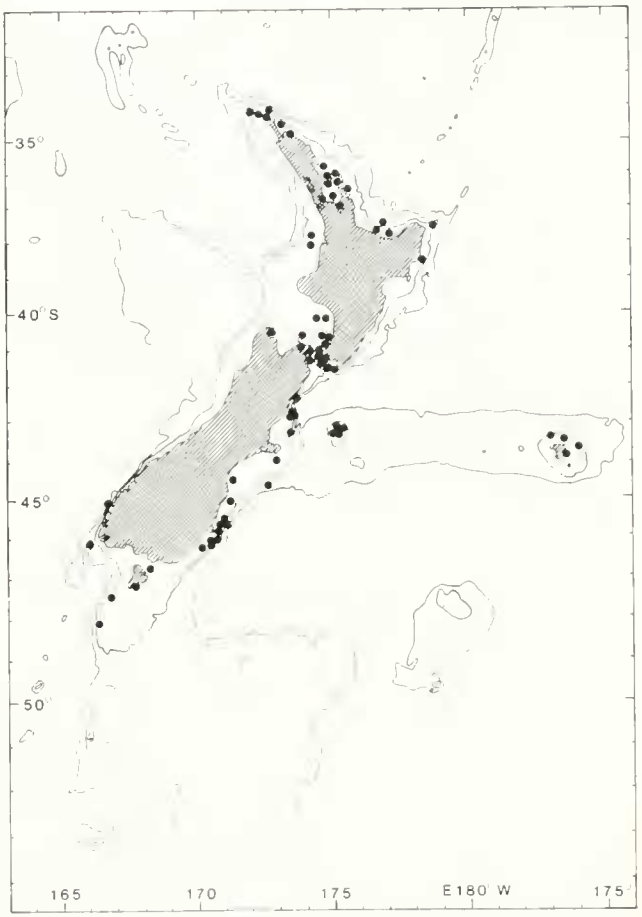


Figure 99. Map of New Zealand region showing distribution of *Calliostoma (Maurea) waikanae*. 200 and 1000 meter contours indicated.

Figures 87-95. *Calliostoma (Maurea) waikanae* Oliver, 1926. **87.** Paratype of *Venustas pellucida haurakiensis* Dell, 1950, Hauraki Gulf, 46 m, MNZ M.15910 (36.9 × 38.3 mm). **88.** Off North Cape, 178-167 m, MNZ M.74670 (51.0 × 51.3 mm). **89.** Off Kawhia, 83 m, MNZ M.74656 (36.5 × 40.0 mm). **90.** Erie Bay, Tory Channel, Wellington, c. 20 m, MNZ M.17931 (41.0 × 42.0 mm). **91.** Between Mana Island and Cape Jackson, Cook Strait, 256-186 m, MNZ M.49913 (32.0 × 36.0 mm). **92.** Off Oamaru, c. 73 m, MNZ M 102589 (50.5 × 51.0 mm). **93.** Foveaux Strait oyster beds, 37-46 m, MNZ M 80567 (48.0 × 52.5 mm). **94.** Bligh Sound, Fiordland, c. 20 m, D. Gibbs collection (42.5 × 41.2 mm). **95.** Off Kaingaroa, Chatham Islands, craypots, MNZ M.92395 (36.2 × 39.0 mm). **Figure 96.** *Calliostoma (Maurea) turnerarum* (Powell, 1964). North of Three Kings Islands, 348-312 m, MNZ M.71984 (47.5 × 56.7 mm). **Figures 97, 98.** *Calliostoma (Maurea) penniketi* Marshall, new species. **97.** Holotype, off Three Kings Islands, c. 55 m, MNZ M.74817 (57.0 × 53.0 mm). **98.** Banfurly Bank, East Cape, 76-71 m, MNZ M.64782 (27.2 × 27.0 mm).

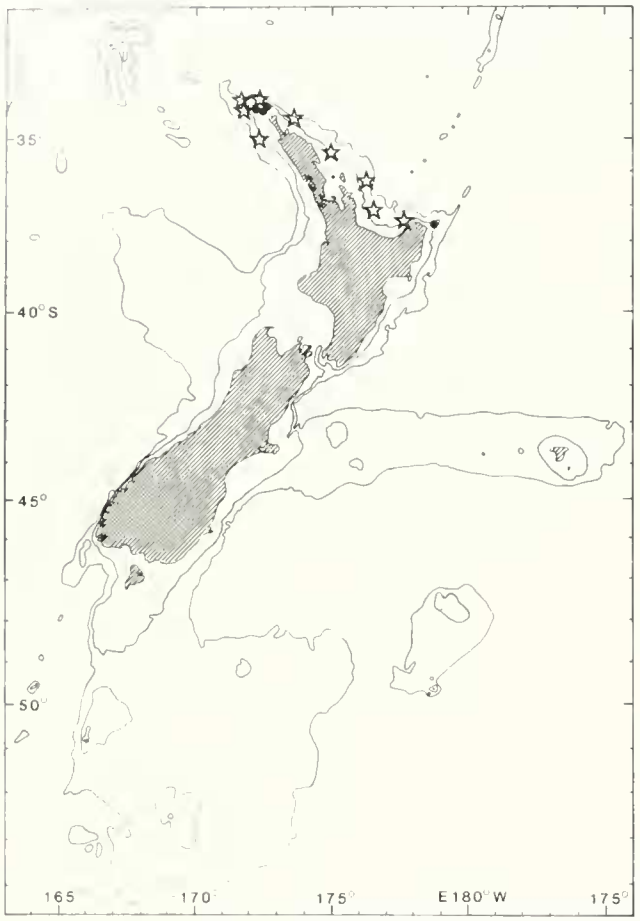


Figure 100. Map of New Zealand region showing distribution of *Calliostoma (Maurea) penniketi* (circle) and *C. (M.) turnerarum* (star). 200 and 1000 meter contours indicated.

sculptured with a network of fine threads that enclose roughly hexagonal spaces, terminal varix strong. Teleoconch of up to 10 whorls, 1st 2.5-3 whorls convex, subsequent whorls more or less flat, last 2 whorls weakly convex. Periphery tightly rounded, becoming rather broadly rounded on last whorl; base almost flat, becoming weakly rounded at maturity. First 3 whorls sculptured with spiral cords, axial riblets, and a few crisp spiral threads, axials and spiral threads weakening and vanishing over next whorl. P1-P4 commencing immediately, P1 thread-like on 1st whorl, gradually enlarging to resemble P2 and P3, which are similar throughout; P4 peripheral, covered by succeeding whorls, becoming exposed by descent of last whorl. S1- S3 commencing on 3rd whorl, enlarging to resemble P1-P3; tertiary spirals commencing on 5th whorl or late on 4th whorl, 1 in each interspace and between P1 and suture, enlarging to resemble secondaries and primaries. Additional finer spirals in each interspace on last few whorls. Spirals about as high as broad with considerably wider interspaces and prominent rounded nodules on 1st 5 whorls, then flattening, becoming smooth, and broadening until separated by shallow grooves; finally becoming strong, crisply nodular and widely spaced on penultimate or last adult whorl. P3 more strongly nodular than P1 and P2 on 3rd and 4th whorls. Adult base with about 18-20 major, spotted, nodular spiral cords, additional finer threads in most interspaces. Aperture subquadrate to subcircular. Outer lip thin at rim, thickened within, strongly so at base. Inner lip a spreading glaze. Parietal glaze thin, restricted to a narrow outer spiral band.

Type Data: Holotype M.74817 (height 57.0 mm, width 53.0 mm, c.10 teleoconch whorls) and 2 paratypes MNZ, off Three Kings Is., c.55 m, alive in craypots, coll. A.D. Howell, pres. M. Sanson. Paratypes (9) : C763, 33°58′S, 172°17.6′E, off Three Kings Is., dead, 73-99 m, 18 February 1962, m.v. *Viti* (1 NZOI); B93, 34°00′S, 172°30′E, alive, 55-91 m, 22 September 1958, m.v. *Viti* (1 NZOI); BS392, 34°08.5′S, 172°11′E, dead, 102 m, 18 February 1974, r.v. *Acheron* (1 MNZ); BS902 (0648), 34°10.5′S, 172°11.4′E, dead, 153 m, 1 February 1981, r.v. *Tangaroa* (1 MNZ); BS901 (0647), 34°14.1′S, 172°09′E, dead, 192-202 m, 1 February 1981, r.v. *Tangaroa* (1 MNZ); BS910 (0656), 34°18.8′S, 172°18.5′E, dead, 93-88 m, 2 February 1981, r.v. *Tangaroa* (2 MNZ); BS911 (0657), 34°20.2′S, 172°21.8′E, dead, 121 m, 2 February 1981, r.v. *Tangaroa* (1 MNZ); BS769 (R127), 37°33.2′S, 178°50.3′E, Ranfurly Bank, East Cape, alive, 76-71 m, 25 January 1979, r.v. *Tangaroa*; BS678 (R36), 37°36.3′S, 178°53.1′E, dead, 74 m, 17 January 1979, r.v. *Tangaroa* (1 MNZ).

Other Material Examined (mostly juveniles): Off Three Kings Islands—50 specimens in 11 lots MNZ; Ranfurly Bank, East Cape—8 specimens in 4 lots MNZ.

Distribution (figure 100): Three King Islands and Ranfurly Bank, East Cape, 55-622 m; taken alive at 55-76 m on rugged, bryozoan/shell substratum with sponges, corals, gorgonians, etc.

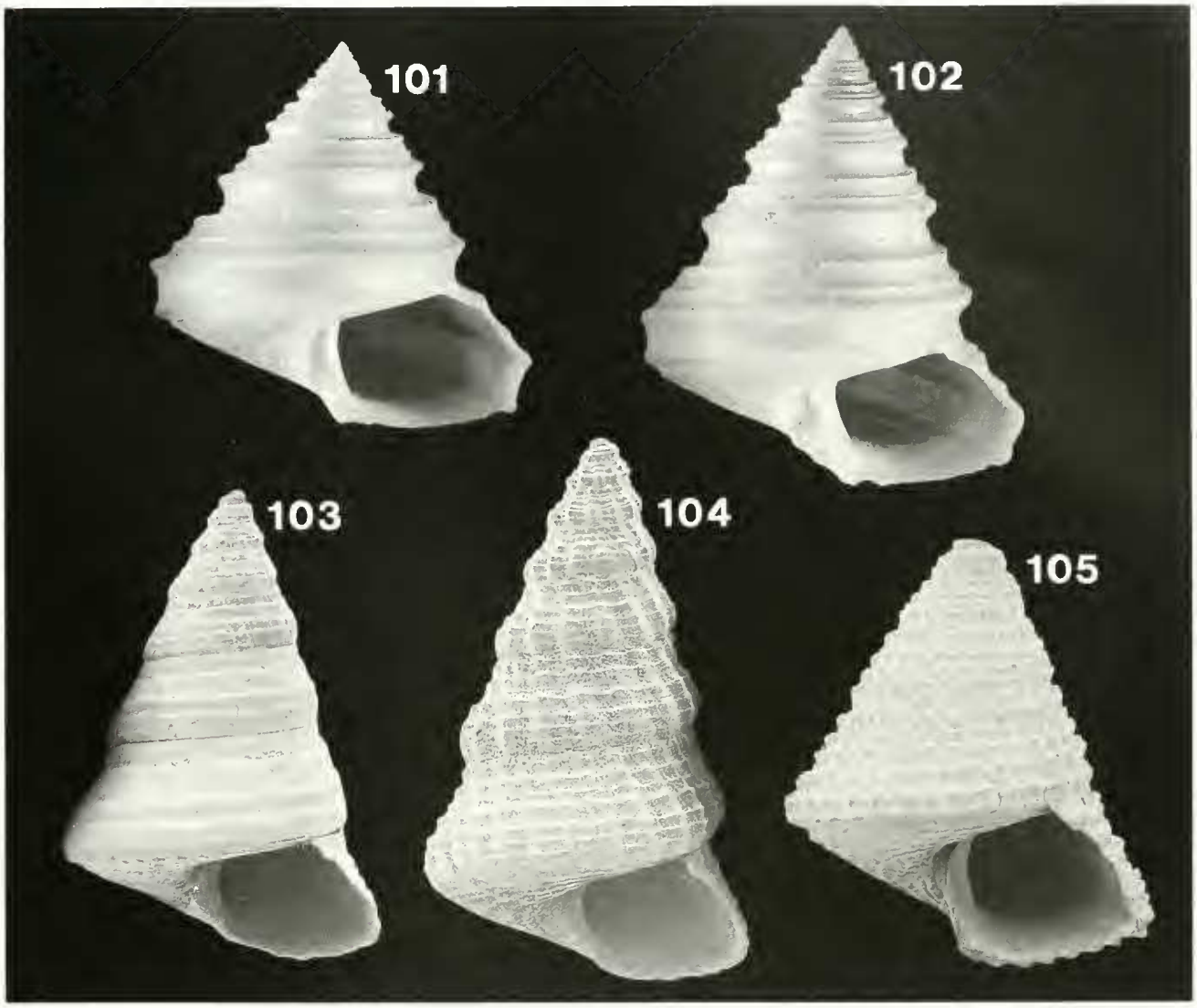
Diet: The alimentary tract of a paratype from off the Three Kings Islands at 55 m contained fragments of thecate hydroids and indeterminate organic material.

Remarks: *Calliostoma penniketi* is closely related to *C. waikanae* and *C. pellucidum*, which it resembles in size, colour, and colour pattern. It is readily separable from them by the finer, more numerous nodules and weaker P3 on the early spire whorls, and in passing through an intermediate growth stage in which the spiral cords become low, broad, and smooth. Specimens from off the Three Kings Islands and East Cape are indistinguishable. *Calliostoma penniketi* may eventually be discovered at intermediate localities, which are as yet inadequately sampled at appropriate depths on hard substrata.

Etymology: Named in honour of the late J.R. (Bob) Penniket, a connoisseur of New Zealand Calliostomatidae, and in recognition for his fostering of New Zealand malacology, both amateur and professional.

Subgenus *Otukaia* Ikebe, 1942

Otukaia Ikebe, 1942.277 Type species (by original designa-



Figures 101, 102. *Calliostoma (Otukaia) alertae* Marshall, new name. **101.** Off Cape Karikari, Northland, 743 m, NZOI F913 (27.0 × 25.7 mm). **102.** Off Bounty Islands, 475 m, NZOI I704 (31.5 × 25.5 mm). **Figure 103.** *Calliostoma (sensu lato) limatulum* Marshall, new species. Holotype, King Bank, north-east of Three Kings Islands, 128 m, MNZ M.90129 (8.05 × 5.50 mm). **Figure 104.** *Calliostoma (sensu lato) onustum* Odhner, 1924 King Bank, north-east of Three Kings Islands, 128 m, MNZ M.50551 (9.85 × 5.50 mm). **Figure 105.** *Calliostoma (sensu lato) kopua* Marshall, new species. Holotype, off Cape Campbell, 454-424 m. MNZ M.59698 (5.35 × 4.95 mm).

tion): *Calliostoma kiheiziebisu* Otuka, 1939; Recent, Japan.

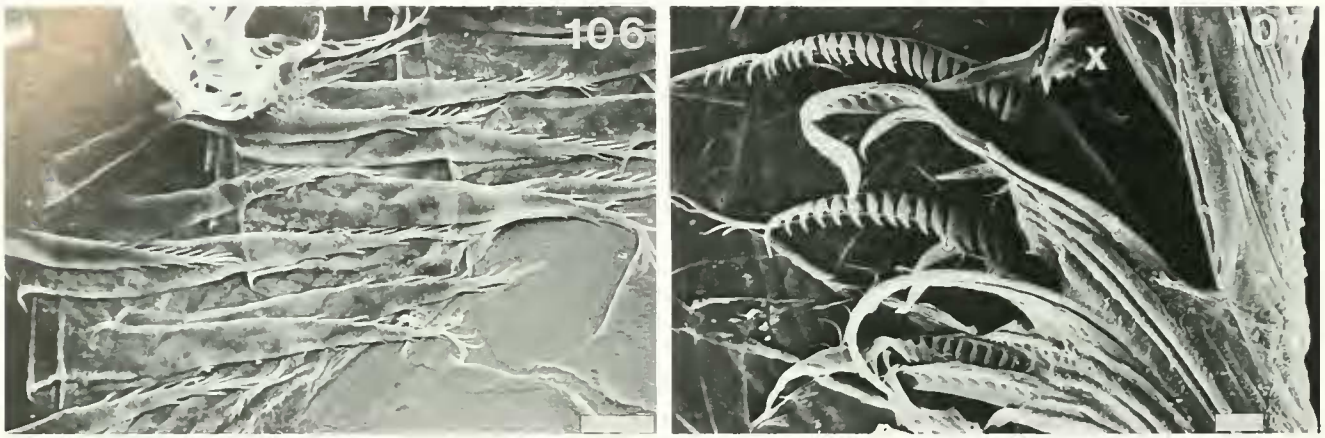
Alertalex Dell, 1956:46. Type species (by original designation): *Alertalex blacki* Dell, 1956 (*Calliostoma alertae* Marshall, new name); Recent, New Zealand.

Remarks: Most members of this group are characterised by a moderate to large-sized shell (height up to 36 mm); strong, smooth or weakly beaded P2 and P3; and the extreme weakness of P1. All have a highly nacreous shell due to translucency of the colourless outer shell layers, and the group (as currently interpreted) occurs worldwide at bathyal depths. The radula, jaw, external anatomy, and development of sculpture on the early teleoconch are essentially similar to those in *Calliostoma* (*sensu stricto*), and I am unable to justify segregation of the group at genus level. Since I am not able to justify placement of *Otukaia* as a synonym of *Calliostoma* either, I follow McLean and Andrade (1982) in interpreting it as a subgenus.

Calliostoma (Otukaia) alertae Marshall, new name
(Figures 101, 102, 108, 122, 141)

Alertalex blacki Dell, 1956:46, figs. 61, 120, 260, Dell 1962:75 (secondary homonym of *Venustas blacki* Powell, 1950).

Otukaia blacki—Dell, 1963:208, Powell, 1979:63, pl. 19, fig 13.



Figures 106, 107. Radula of holotype of *Calliostoma (sensu lato) kopua* Marshall, new species. **106.** Central and lateral teeth. **107.** Marginal teeth, innermost tooth indicated (x). Scale bars = 10 μm.

Type Data: Holotype MNZ M.9767 and 1 paratype MNZ: 44°04′S, 178°04′W, Chatham Rise, alive, 476 m, 10 February 1954, m.v. *Alert*. Paratypes (4 MNZ): 43°42′S, 179°55′E, Chatham Rise, alive, 512 m, 24 January 1954, m.v. *Alert*.

Other Material Examined: 17 specimens in 12 lots MNZ, 30 specimens in 20 lots NZOI.

Distribution (figure 108): Off Cape Brett southward to off The Snares, Challenger Plateau, Chatham Rise, Bounty Plateau, and Pukaki Rise (34°43.5′S-49°02′S), living at 280-861 m on muddy substrata with shells.

Diet: Gut contents of the few specimens examined comprise much indeterminate organic matter together with fragments of thecate hydroids (Cnidaria).

Remarks: Since *Otukaia* is here interpreted as a subgenus of *Calliostoma*, *C. (Otukaia) blacki* (Dell, 1956) becomes a homonym of the prior *C. (Maurea) blacki* (Powell, 1950). In the absence of junior synonyms it is here renamed *C. (O.) alertae*. Should *Otukaia* prove to be worthy of genus-group status, the specific name will revert to the original (ICZN Art 59d).

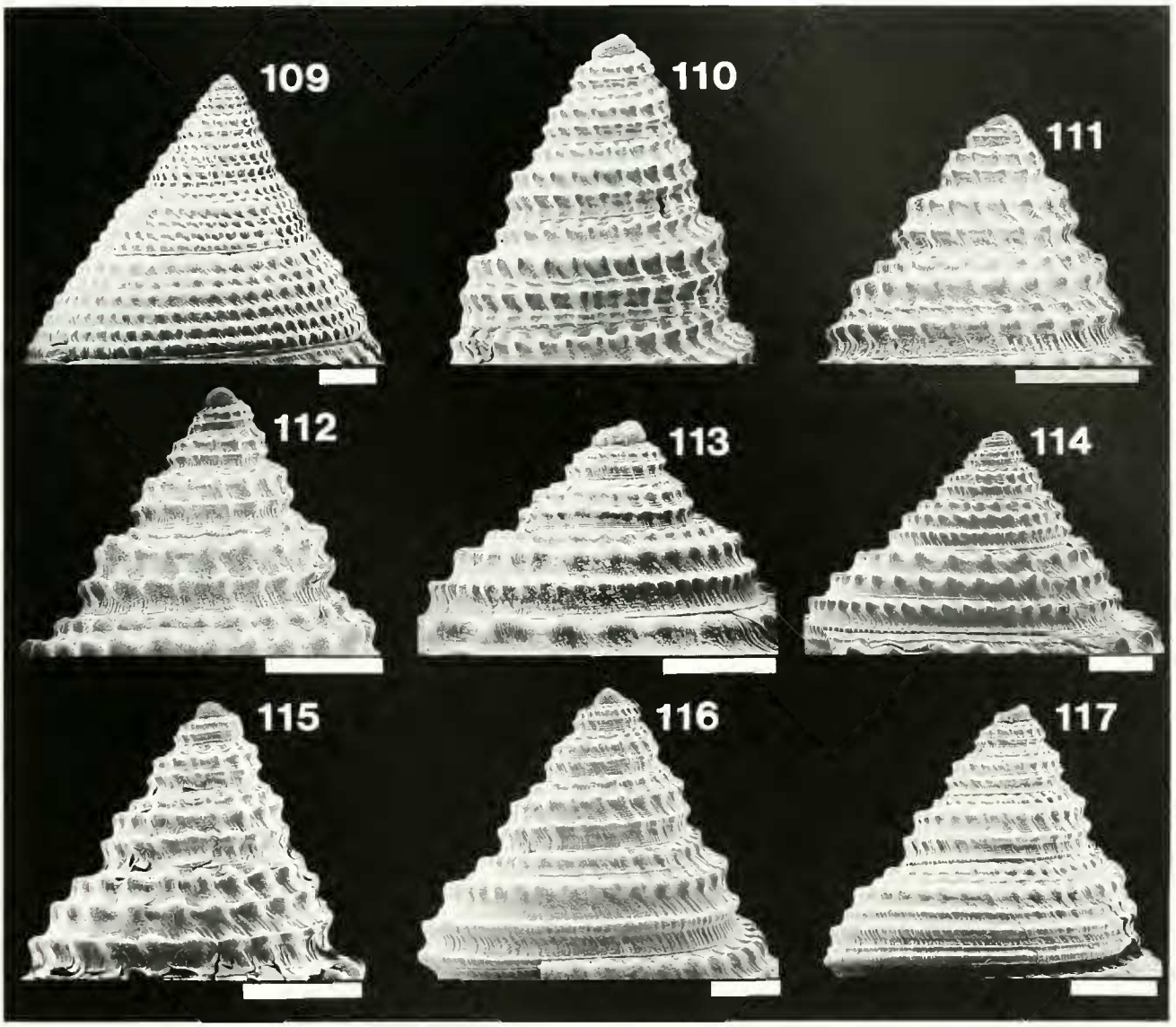
This species is strongly characterised by its iridescent, weakly nodular shell, very strong P2 and P3, the late appearance and extreme weakness of P1, and the strong development of S2, which enlarges to resemble P2.

Calliostoma alertae shows slight southward narrowing of the spire angle, which ranges from 61° to 70° (mean 65.7°, $n = 7$) in material from north of East Cape (figure 101) and 55° to 60° (mean 57.8°, $n = 7$) in specimens from the Bounty Platform (figure 102). Specimens from these extreme northern and southern populations also have respectively the most lightly and heavily built shells. Material from geographically intermediate localities are intermediate in spire angle and shell thickness.

Calliostoma (sensu lato) onustum Odhner, 1924
(Figures 104, 108, 124, 142)

←

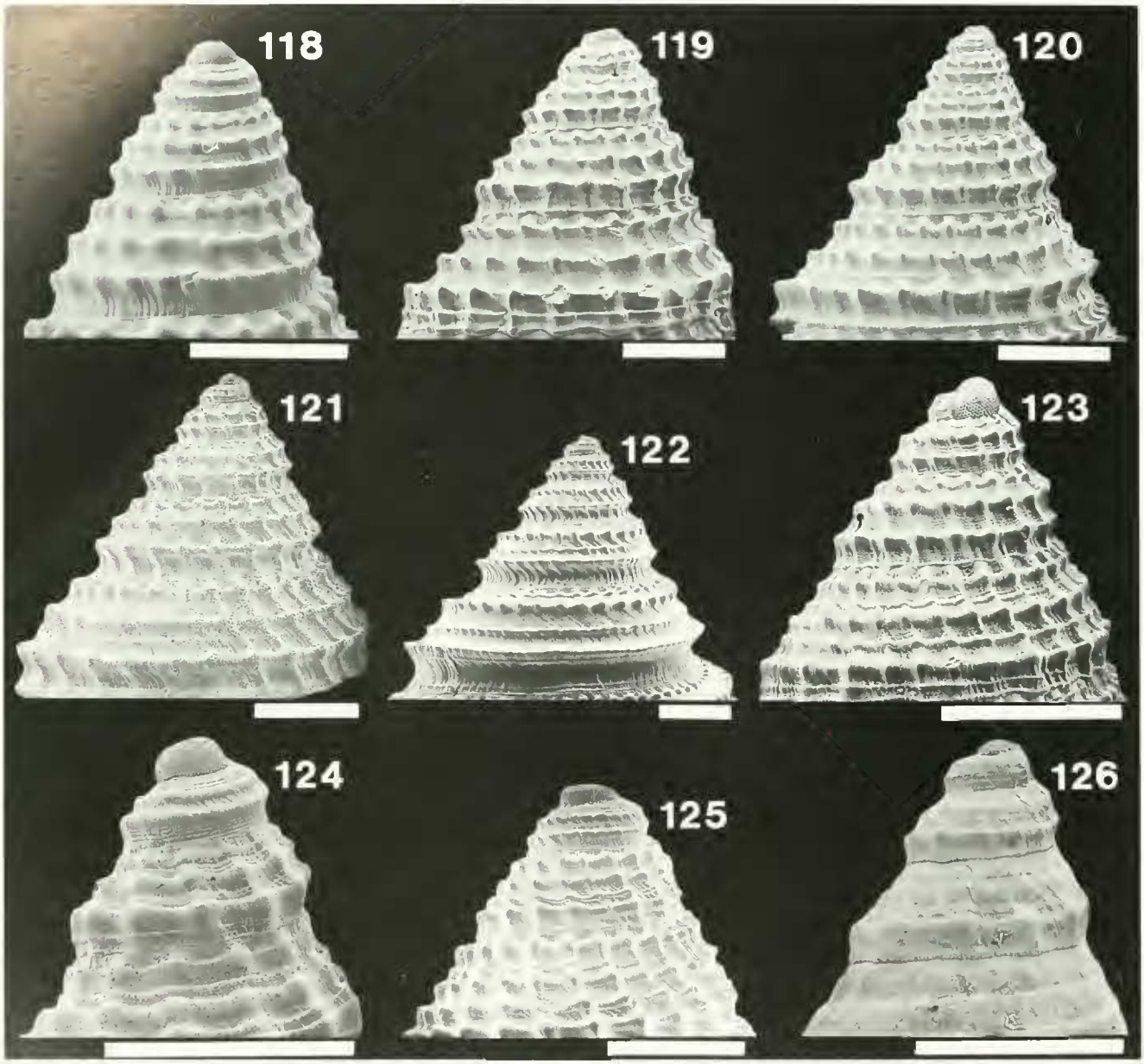
Figure 108. Map of New Zealand region showing distributions of *Calliostoma (Otukaia) alertae* (dot), both *C.* (s.lat.) *limatulum* and *C. (s. lat.) onustum* (star), and *C. (s. lat.) kopua* (open circle). 200 and 1000 meter contours indicated.



Figures 109-117. Early whorls of *Calliostoma* species. **Figure 109.** *Calliostoma (Maurea) gibbsorum* Marshall, new species. Off Three Kings Islands, craypot, MNZ M.74663. **Figure 110.** *Calliostoma (Maurea) tigris* (Gmelin, 1791). Whangaroa Harbour entrance, 20 m, MNZ M.41060. **Figure 111.** *Calliostoma (Maurea) regale* Marshall, new species. Holotype, off Three Kings Islands, 153 m, MNZ M.86730. **Figure 112.** *Calliostoma (Maurea) aupourianum* Marshall, new species. Holotype, off Three Kings Islands, 252 m, MNZ M.86731. **Figure 113.** *Calliostoma (Maurea) spectabile* (A. Adams, 1855). Off Auckland Islands, 42-44 m, NZOI D71. **Figure 114.** *Calliostoma (Maurea) foveauxanum* (Dell, 1950). Off Otago Peninsula, 220 m, MNZ M.8939. **Figure 115.** *Calliostoma (Maurea) blacki* (Powell, 1950). Off Otago Peninsula, 476-549 m, MNZ M.8891. **Figure 116.** *Calliostoma (Maurea) simulans* Marshall, 1994. Paratype, wall of Pegasus Canyon, off Banks Peninsula, 329-183 m, MNZ M.64654. **Figure 117.** *Calliostoma (Maurea) antipodense* Marshall, new species. Paratype, off Antipodes Islands, 103 m, MNZ M.80469. Scale bars = 1mm.

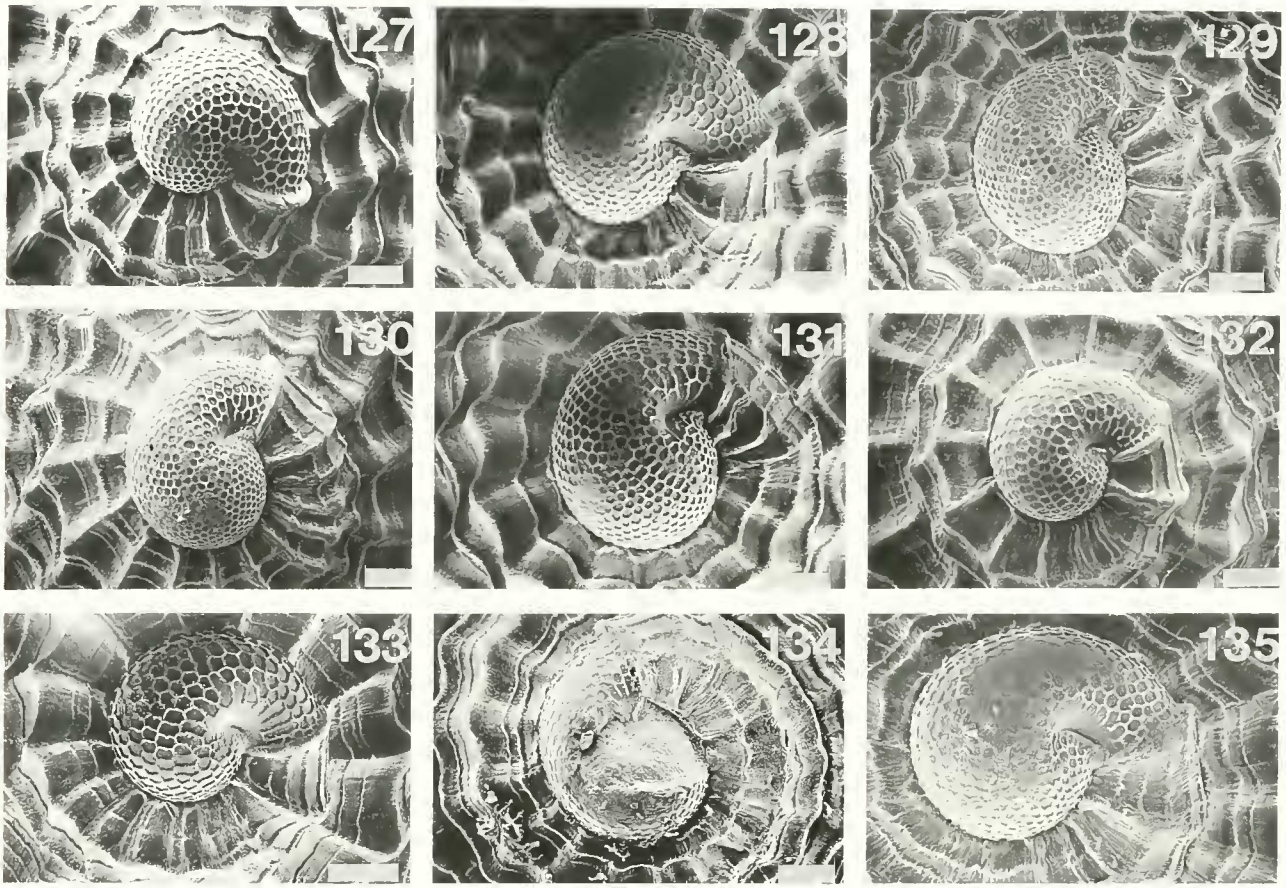
Calliostoma onustum Odhner, 1924:16, pl. 1, fig. 4.
Calliostoma (Maurea) onustum—Oliver, 1926:108.
Fautor onustus—Finlay, 1926:360; Powell, 1979:63, pl. 19, fig. 12.

Description: Shell up to 6.63 mm high, of moderate thickness, considerably higher than broad; spire narrowly and evenly conical, up to 3.4 × higher than aperture; juveniles with minute umbilical chink, larger specimens anomphalous. Iridescent nacreous through translucent outer shell layer, which is colourless when fresh, dead specimens white, base and P4 pale buff in some specimens, protoconch and 1st teleoconch whorl pink in some specimens. Protoconch 320-330 μm wide, sculptured with fine threads that enclose hexagonal spaces, terminal varix strong, rounded. Teleoconch of up to 6.50 whorls, 1st whorl rounded, next 2 angulated at P3; subsequent whorls rounded over abapical half, weakly concave adapically; periphery narrowly rounded, base more or less flat. First



Figures 118-126. Early whorls of *Calliostoma* species. **Figure 118.** *Calliostoma (Maurea) selectum* (Dillwyn, 1817). Tasman Bank, Golden Bay, 26-24 m, MNZ M.50508. **Figure 119.** *Calliostoma (Maurea) pellucidum* (Valenciennes, 1846). Off Stephens Island, Cook Strait, 183-187 m, MNZ M.50269. **Figure 120.** *Calliostoma (Maurea) waikanae* Oliver, 1926. Pelorus Sound mouth, 29 m, MNZ M.51450. **Figure 121.** *Calliostoma (Maurea) turnerarum* (Powell, 1964). Off Great Island, Three Kings Islands, 440 m, MNZ M.118380. **Figure 122.** *Calliostoma (Otukaia) alertae* Marshall, new name. Wall of Pegasus Canyon, off Banks Peninsula, 1006-512 m, MNZ M.52781. **Figure 123.** *Calliostoma (Maurea) penniketi* Marshall, new species. Off Three Kings Islands, 187 m, MNZ M.34246. **Figure 124.** *Calliostoma (sensu lato) onustum* Odhner, 1924. Off Three Kings Islands, King Bank, north-east of Three Kings Islands, 128 m, MNZ M.50551. **Figure 125.** *Calliostoma (sensu lato) kopua* Marshall, new species. Holotype, off Cape Campbell, 454-424 m, MNZ M.59698. **Figure 126.** *Calliostoma (sensu lato) lunatulum* Marshall, new species. Holotype, King Bank, north-east of Three Kings Islands, 128 m, MNZ M.90129. Scale bars = 1mm.

c. 0.3 whorl demarcated by growth scar, not sculpturally differentiated from succeeding half whorl. First 1.5 whorls with fine, crisply defined spiral threads. Spiral cords rounded, sharply shelved adapically, nodular where traversing axial costae, multiplying by intercalation from 3 (P2-P4) to 7 (P1-P4, S1-S3); interspaces concave, about as wide as each spiral. Spiral cords enlarging from the spiral threads. P1 commencing later than P2-P4, which are similar throughout, P1 as large as them after 2nd whorl. Summit of P4 exposed on spire throughout. Secondary spirals rapidly enlarging to resemble primaries; S1 commencing on late 2nd to late 3rd whorl, S2 on mid



Figures 127-135. Protoconchs of *Calliostoma* species. **Figure 127.** *Calliostoma (Maurea) tigris* (Gmelin, 1791). Whangaroa Harbour entrance, 20 m, MNZ M.41060. **Figure 128.** *Calliostoma (Maurea) punctulatum* (Martyn, 1784). Cook Strait, 256-254 m, MNZ M.54911. **Figure 129.** *Calliostoma (Maurea) granti* (Powell, 1931). Off Stephens Island, Cook Strait, 183-187 m, MNZ M.50266. **Figure 130.** *Calliostoma (Maurea) gibbsorum* Marshall, new species. Off Three Kings Islands, 102 m, MNZ M.34249. **Figure 131.** *Calliostoma (Maurea) osborncі* Powell, 1924. Off Wanganui, 33-35 m, MNZ M.118381. **Figure 132.** *Calliostoma (Maurea) regale* Marshall, new species. Off Three Kings Islands, 102 m, MNZ M.80699. **Figure 133.** *Calliostoma (Maurea) aupourianum* Marshall, new species. Middlesex Bank, north-west of Three Kings Islands, 246-291 m, MNZ M.80675. **Figure 134.** *Calliostoma (Maurea) spectabile* (A. Adams, 1855). Off Auckland Islands, 42 m, NZOI D71. **Figure 135.** *Calliostoma (Maurea) foveauxanum* (Dell, 1950). Off Otago Peninsula, 220 m, MNZ M.8939. Scale bars = 100 μm.

2nd to early 3rd whorl, S3 on late 1st to mid 2nd whorl. Axial costae commencing late on 1st whorl, gently prosocline, non-collabral, entirely traversing all subsequent whorls, very strong between P2 and P4, numbering 16-20 on 5th whorl. Base with 7-9 similar, rounded spiral cords, their outer edges beveled, at first smooth, becoming weakly nodular with increasing shell size; interspaces wider than each spiral in most specimens but narrower in a few specimens. Collabral growth lines prosocline on spire, opisthocyrt on base. Aperture subquadrate, inner and outer lips thin and simple, parietal glaze very thin.

Type Data: Lectotype (Odhner's described and illustrated specimen here selected) and 1 paralectotype, Zoological Museum, Copenhagen : 10 miles NW of Cape Maria van Diemen, dead, 91 m, 4 January 1915.

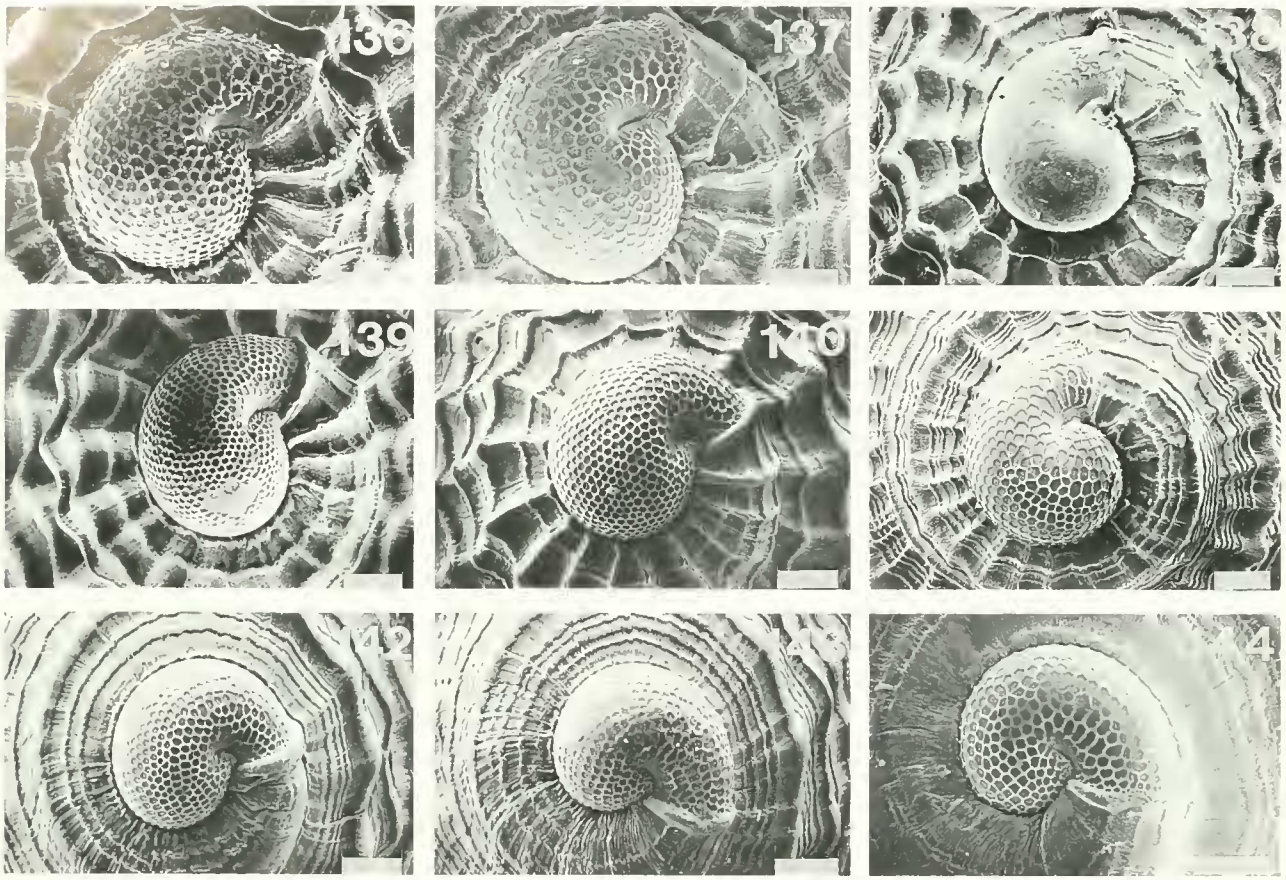
Other Material Examined: 48 specimens in 12 lots MNZ.

Distribution (figure 108): Off Three Kings Islands and off Cape Reinga (33°57.0'S-34°25.0'S), 55-310 m, taken alive at 102-202 m on rugged, bryozoan/shell substratum with sponges, gorgonians, and hydroids.

Diet: Unknown.

Remarks: Among previously described taxa, *Calliostoma onustum* most closely resembles the southern Australian species *C. retiarium* Hedley & May, 1908, from which it differs in having a flattened or concave shoulder on the teleoconch whorls and broader spiral cords. The smaller specimen (paralectotype) recorded by Odhner (1924) is an immature specimen of *Thysanodonta wairua* Marshall, 1988 (Calliostomatidae : Thysanodontinae).

Marshall (1995) will refer this species to a new genus based on the highly distinctive shell morphology and



Figures 136-144. Protoconchs of *Calliostoma* species. **Figure 136.** *Calliostoma (Maurea) blacki* (Powell, 1950). Off Otago Peninsula, 476-549 m, MNZ M.8891. **Figure 137.** *Calliostoma (Maurea) simulans* Marshall, 1994. Paratype, wall of Pegasus Canyon, off Banks Peninsula, 329-183 m, MNZ M.64654. **Figure 138.** *Calliostoma (Maurea) antipodense* Marshall, new species. Paratype, off Antipodes Islands, 103 m, MNZ M.80469. **Figure 139.** *Calliostoma (Maurea) waikanae* Oliver, 1926. Pelorus Sound mouth, 29 m, MNZ M.51450. **Figure 140.** *Calliostoma (Maurea) penniketi* Marshall, new species. Off Three Kings Islands, 187 m, MNZ M.34246. **Figure 141.** *Calliostoma (Otukaia) alertae* Marshall, new name. Wall of Pegasus Canyon, off Banks Peninsula, 1006-512 m, MNZ M.52781. **Figure 142.** *Calliostoma (sensu lato) onustum* Odhner, 1924. Off Three Kings Islands, 102 m, MNZ M.34251. **Figure 143.** *Calliostoma (sensu lato) kopua* Marshall, new species. Holotype, off Cape Campbell, 454-424 m, MNZ M.59698. **Figure 144.** *Calliostoma (sensu lato) limatulum* Marshall, new species. Off Three Kings Islands, 102 m, paratype, MNZ M.118382. Scale bars = 100 μm.

degenerate radula (figures 106, 107). *C. retiarium* and the two new taxa described below are congeneric.

Calliostoma (sensu lato) limatulum Marshall, new species
(Figures 103, 108, 126, 144)

Description: Shell up to 6.60 mm high, of moderate thickness; higher than broad, considerably so at maturity; some juveniles with minute umbilical chink, adults anomphalous; spire narrowly and evenly conical, up to 2.9 × higher than aperture. Iridescent nacreous through translucent outer shell layer, which is colourless when fresh, dried specimens becoming white; occasionally with a few scattered irregular patches of pale buff; protoconch and 1st 1 or 2 teleoconch whorls sometimes pink. Protoconch 330 μm wide, sculptured with fine threads that enclose hexagonal spaces, terminal varix strong, rounded. Teleoconch of up to 6.10 whorls, 1st whorl rounded, subsequent whorls flattened adapically, angulate at P3 on 2nd and 3rd whorls, rounded thereafter, periphery narrowly rounded, base more or less flat. First c. 0.3 whorl demarcated by growth scar, not sculpturally differentiated from succeeding half whorl. First 1.5 whorls with fine, crisply defined spiral threads. Spiral cords enlarging from fine threads, rounded, sharply shelved adapically, multiplying by intercalation from 3 (P2-P4) to 5 or occasionally 6 (P1-P4, S2±S1), interspaces narrower than each spiral, P3 and P4 becoming most closely spaced. Spiral cords enlarging from fine threads. P1 commencing later than P2 and P3, after mid 2nd-4th whorl as large as P2; P2 and P3 of similar size on 1st whorl, P3 stronger thereafter; summit of P4 exposed on spire throughout. When present, S1 either developing in parallel with P1 and resembling it throughout or commencing as late as mid 4th whorl and enlarging to resemble P1; S2 com-

mencing on late 1st or on 2nd whorl, as large as P1 and P2 after late 3rd whorl. Spirals nodular on early whorls, strongly so on P3 and P4, on 4th or 5th whorl nodules weakening and vanishing from all spirals, which are smooth thereafter. Early spire whorls either entirely traversed by strong axial costae, or costae strong between S2 and P4 and weaker adapically. Axials obsolete after 3rd-5th whorl. Base with 7 or 8 broad, smooth, rounded spiral cords with interspaces considerably narrower than each spiral, occasionally with up to 12 finer cords. Collabral growth lines prosocline on spire, opisthocyrt on base. Aperture subquadrate, inner lip thin.

Type Data: Holotype MNZ M.90129 (height 8.05 mm, diameter 5.50 mm, 7.00 teleoconch whorls), BS 904 (0650), 33°57.0′S, 172°19.0′E, King Bank, NE of Three Kings Is., dead, 128 m, 1 February 1981, r.v. *Tangaroa*. Paratypes (31 MNZ): BS 898 (0644), 34°01.2′S, 171°44.4′E, dead, 206-211 m, 31 January 1981, r.v. *Tangaroa* (2); BS 637 (P485), 34°05.0′S, 172°24.6′E, dead, 200 m, 24 June 1978, r.v. *Tangaroa* (1); BS 392, 34°08.5′S, 172°11.0′E, alive, 102 m, 18 February 1974, r.v. *Acheron* (8); BS 901 (0647), 34°14.1′S, 172°09.0′E, alive, 192-202 m, 1 February 1980, r.v. *Tangaroa* (11); BS 911 (0657), 34°20.2′S, 172°21.8′E, alive, 121 m, 2 February 1981, r.v. *Tangaroa* (6); BS 912 (0658), 34°22.8′S, 172°24.6′E, dead, 121 m, 2 February 1981, r.v. *Tangaroa* (2); BS 631 (P441), 34°24.0′S, 172°16.8′E, dead, 120 m, 20 June 1978, r.v. *Tangaroa* (1).

Other Material Examined: 72 specimens in 10 lots MNZ.

Distribution (figure 108): Off Three Kings Islands and off Cape Reinga, 91-805 m, taken alive at 102-310 m on rugged, bryozoan/shell substratum with sponges, gorgonians, and hydroids.

Diet: Unknown.

Remarks: *Calliostoma limatulum* is closely similar to the sympatric species *C. onustum*, differing principally in being more broadly conical, in having axial costae confined to the early spire whorls, in having an extra spiral cord on the spire (S3), and in that the spiral cords on the spire become broader and smooth with increasing shell size. The two species have identical protoconch and first teleoconch whorl morphologies, and they are similar in shell structure and shell size relative to the number of whorls. Their geographic and bathymetric distributions are similar, and they commonly occur together in dredge samples. I have not overlooked the possibility that they may be forms of a single sexually dimorphic species, but without knowledge of the reproductive anatomy it is impossible to tell.

Calliostoma (sensu lato) kopua Marshall, new species (Figures 105, 106, 107, 125, 143)

Description: Shell up to 5.35 mm high, slightly higher than broad, with minute umbilical chink; spire evenly conical, up to 1.78 × higher than aperture. Iridescent nacreous through colourless, translucent outer shell layer. Protoconch 320 μm wide, sculptured with fine threads that enclose hexagonal spaces, terminal varix strong, rounded. Teleoconch of up to 4.70 whorls, 1st whorl convex, subsequent whorls flat sided, periphery angulate; base almost flat at first, becoming weakly convex. A growth scar almost immediately after protoconch. First 1.5 whorls with fine, crisply defined spiral threads. Spiral cords on spire angulate in section, sharply beveled adapically, with rounded conical nodules where traversing axials, multiplying by intercalation from 3 (P2-P4) to 6 (P1-P4, S1, S2), summit of P4 exposed on spire; interspaces concave, broader than each spiral, P3 and P4 becoming closer than others with increasing shell size. P1 very weak on 1st whorl, by end of 2nd whorl as large as P2 and P3, which are similar throughout, P3 peripheral, summit of P4 exposed on spire throughout. Secondary spirals developing to resemble primaries, S1 commencing on early to late 3rd whorl, S2 commencing on 1st half of 2nd whorl; axial costae commencing at end of 1st whorl, strong, prosocline, entirely traversing all spire whorls to P4. Base with 7 or 8 similar, strong, rounded spiral cords, at first smooth then with small rounded nodules, interspaces about as wide as each spiral or wider. Surface minutely granulate throughout. Collabral growth lines prosocline on spire, opisthocyrt on base. Aperture subquadrate. Radula (figures 106-107) with formula c.6 + 3 + 1 + 3 + c.6, highly degenerate, all teeth other than innermost 2 pairs of marginals flexible, almost gelatinous. Central and lateral teeth slender, narrowly tapered, extremely thin in section, tips finely serrate. Innermost marginal shortest, stoutest, cutting area angulate, strong terminal cusp and 3 or 4 secondary cusps on each side. Outer marginals slender, innermost pair longest, cutting area with long series of stout, narrowly tapered, curved cusps; outer marginals weakly developed.

Type Data: Holotype MNZ M.59698 (height 5.35 mm, width 4.95 mm, 4.70 teleoconch whorls): BS 668 (R26), 41°55.9′S, 174°43.2′E, SE of Cape Campbell, alive, 454-424 m, 14 January 1979, r.v. *Tangaroa*. Paratypes (4 MNZ): BS 969 (R27), 41°55.8′S, 174°40.7′E, SE of Cape Campbell, alive, 434-446 m, 14 January 1979, r.v. *Tangaroa*.

Other Material Examined: 1 incomplete shell MNZ, 45°45′S, 171°02′E, off East Otago, 600-520 m, r.v. *Munida*.

Distribution (figure 108): Off Cape Campbell and off East Otago, 424-600 m, taken alive at 424-454 m from rugged substrata with shells and corals.

Diet: Unknown.

Remarks: Compared with the Australian species *Calliostoma retiarium*, which it most closely resembles, *C. kopua* differs principally in being more strongly nodular, in being larger relative to the number of whorls, and in having a less excert protoconch. The single incomplete shell from off East Otago is 6.55 mm in diameter (estimated height 7 mm), suggesting that the type specimens are immature. As in other members of this group the

radula is degenerate through developmental retardation, *C. kopua* having the most degenerate radula of any known calliostomatid.

Etymology: Deep (Maori).

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APPENDIX
CHECKLIST OF RECENT CALLIOSTOMATIDAE FROM THE NEW ZEALAND REGION WITH NEW SYNONYMS
CALLIOSTOMATINAE
Calliostoma (Maurea) antipodense Marshall, new species.
C.(M.) aupourianum Marshall, new species.
C.(M.) benthicola (Dell, 1950).
C.(M.) blacki (Powell, 1950) (= *couperi* Vella, 1954 = *profunda* Dell, 1956).
C.(M.) eminens Marshall, new species.
C.(M.) foveauxanum (Dell, 1950).
C.(M.) gibbsorum Marshall, new species.
C.(M.) granti (Powell, 1931) (= *ampla* Powell, 1939 = *multigemmata* Powell, 1952).
C.(M.) jamiesoni Marshall, new species.
C.(M.) maui Marshall, new species.
C.(M.) megaloprepes (Tomlin, 1948).
C.(M.) osbornei Powell, 1926.
C.(M.) pellucidum (Valenciennes, 1846) (= *undulatum* Finlay, 1923 = *spiratum* Oliver, 1926).
C.(M.) penniketi Marshall, new species.
C.(M.) punctulatum (Martyn, 1784).
C.(M.) regale Marshall, new species.
C.(M.) selectum (Dillwyn, 1817) (= *hodgei* Hutton, 1875 = *ponderosus* Hutton, 1885 = *carnicolor* Preston, 1907).
C.(M.) simulans Marshall, 1994
C.(M.) spectabile (A. Adams, 1855).
C.(M.) tigris (Gmelin, 1791) (*chathamensis* Dell, 1950).
C.(M.) turnerarum (Powell, 1964).
C.(M.) waikanae Oliver, 1926 (= *morioria* Powell, 1946 = *forsteriana* Dell, 1950 = *haurakiensis* Dell, 1950).
C.(Otukaia) alertae Marshall, new name (*blacki* Dell, 1956).
C. (sensu lato) kopua Marshall, new species.
C. (sensu lato) limatulum Marshall, new species.
C. (sensu lato) onustum Odhner, 1924.
New genus A, new species (Marshall, 1995).
New genus B, new species (Marshall, 1995).
THYSANODONTINAE
Thysanodonta aucklandica Marshall, 1988.
T. wairua Marshall, 1988.
Carinastele coronata Marshall, 1988
C. jugosa Marshall, 1988.
C. kristellae Marshall, 1988

Five additional calliostomatines are known from the Kermadec Islands, to the north-east of New Zealand (Marshall, 1979):
Calliostoma new species A = *C. (Tristichotrochus)* sp. cf. *simplex* of Marshall, 1979, figs. C, D, not Schepman, 1908 (Marshall, 1995).
C. new species B = *C. (T.)* sp. cf. *simplex* of Marshall, 1979, figs. E, F, not Schepman, 1908 (Marshall, 1995).
C. *(Tristichotrochus) gendalli* Marshall, 1979.
C. *(T.)* species cf. *tosaense* (Kuroda & Habe, 1961).
C. *(Fautor) consobrinum* (Powell, 1958).